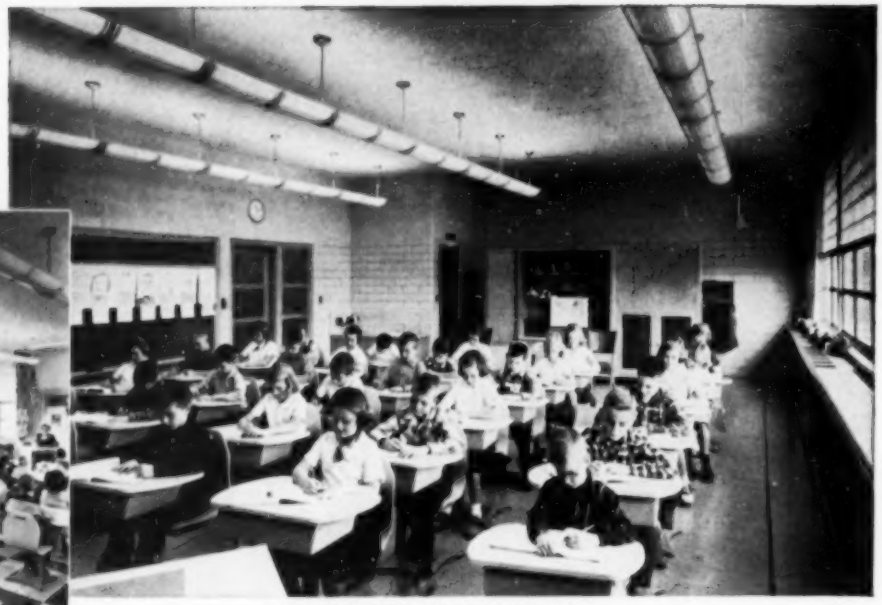
ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

Architect: Berger, Kelley & Samuelson, Champaign, Illinois.

Electric Contractor: Olch Electric Company, Chicago.

Kindergarten with three rows of Stars (one row not shown).



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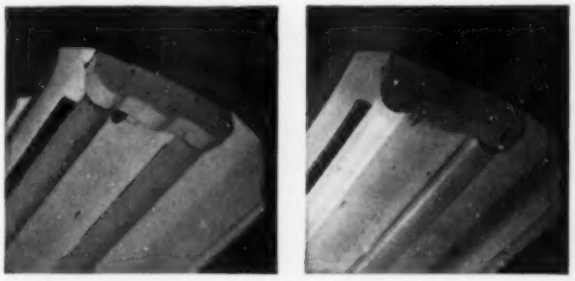

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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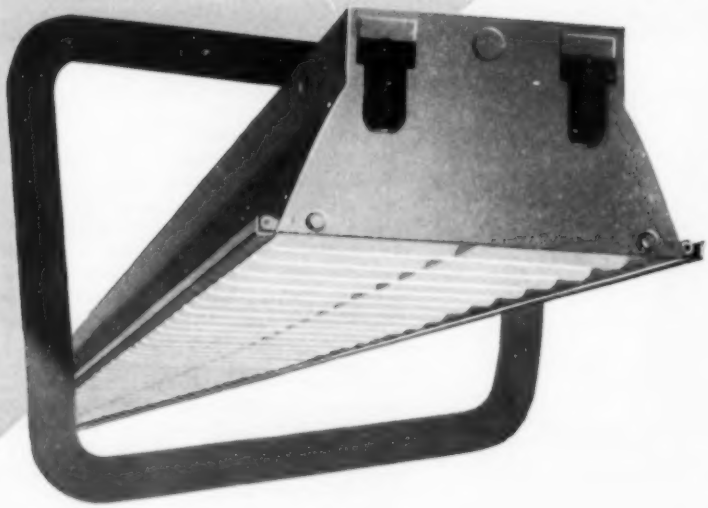

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More Tips on Lighting Photography

By TOM KNOWLES

PRODUCING good photographs of lighting installations, a skill for which there is an increasing demand, may well be one of the most difficult photographic assignments. The photographer is expected to reproduce the existing lighting effect as realistically as possible and, because of this, is denied his normal use of light as a major control in the exposure of the negative. Added to this is the probability that the existing illumination produces brightness ratios well beyond the contrast range of the photographic materials available.

In view of this substantial handicap, a good lighting photograph requires careful attention throughout the production stages of composition, exposure, and printing. The growing use of color film for magazine illustrations and lantern slides of lighting installations adds the problem of proper chromatic rendition. This article will discuss some of the things which merit consideration during each stage in the production of a successful lighting photograph.

Composition

For accurate composition, a camera with ground glass viewing is a must. It should also be equipped with adequate front and rear swings to permit correction of distortion of horizontal and vertical architectural lines. All vertical lines in the scene should be vertical in the photograph (and therefore parallel to each other), providing the camera angle is not more than 35 degrees from the horizontal. To insure this, the plane of the film must be vertical during exposure. This positioning reduces the apparent distortion in such subjects as machinery, store windows, and building exteriors.

The horizontal swings of the camera are used to reduce the apparent pin-pointing of the horizontal lines. In controlling the perspective of these lines, the plane of the film should approach the plane of the subject.

Most view cameras have an adjustment which allows the lens to be inclined slightly toward the plane of the subject. By careful use of this adjustment, the depth of field can be increased without necessarily using small lens stops. This technique is valuable when people are included in the scene.

Much of the realism of a photograph depends on the faithfulness with which perspective is reproduced. Since this is affected by several factors during the production of a photograph, it should be considered from the start. Perspective in a print is determined by the focal length of the camera lens, the degree of enlargement of the print, and the distance at which the print is viewed. For correct perspective, the focal length of the taking lens, multiplied by the linear enlargement of the print, should equal the viewing distance.

Focal Length × *Enlargement* = *Viewing Distance*

As an example of this relationship, assume that an interior photograph is taken with a camera equipped with a seven-inch lens. If the print is made by contact printing (which might be called an enlargement of one), the correct viewing distance would be seven inches — too close to be comfortable. As 14 inches is considered to be the average viewing distance for hand-held matter, this print would likely be seen at this distance and, therefore, should be enlarged by a factor of two (14 divided by 7) for proper perspective.

Looking at this relationship in another way, if the final reproduced print, perhaps as a magazine illustration, will be 4 x 5 inches in size and the photograph is originally taken with a camera having a seven-inch lens, the useful negative area will be 2 x 2½ inches if the perspective is to be true. If the camera has a 3½-inch lens, the useful negative area would be 1 x 1¼ inches. All of these examples are based on the average viewing distance of 14 inches. They demonstrate the difficulty of reconciling the short focal length of the wide angle lenses generally used for interior photography with the normal size of published pictures. Compromise is necessary.

True perspective in lantern slides for projection was discussed in an article by Knowles and Toenjes, entitled "Techniques for Photography of Lighted Streets." (ILLUMINATING ENGINEERING, January 1953.)

AUTHOR: Application Engineering Division, General Electric Co., Nela Park, Cleveland, Ohio.

Figure 1. (left) This show window was photographed by existing lighting only. The exposure time may be based on the incident light if it can be measured inside the window. However, when exposures must be determined from outside the store window, a brightness meter is used to appraise the scene's brightness range. Objectionable reflections can usually be avoided when selecting the camera position. Screens may be used to shade the window from otherwise unavoidable reflections. Exposure for this photograph was based on the brightness of the white display card for the highlight and the darkest wall area where some shadow detail was to be retained. The white card measured 45 footlamberts and the shadow area measured 1.5 footlamberts. Exposure was 2 seconds at f-16 on fast panchromatic film, ASA-100.

Figure 2. Exposure for this interior scene was based on the incident footcandles on the back wall near the floor. With the light cell aimed toward the camera, the reading was 8 footcandles. Exposure was 20 seconds at f-22 on fast panchromatic film, ASA-100.

Figure 3. Exposure for this scene was based on an incident light reading of 4 footcandles. The light-sensitive cell was aimed toward the camera. Exposure 40 seconds, lens setting f-22, fast panchromatic film ASA-100.

Exposure

Fortunately, with improvements in photographic emulsions and in lighting installations, most scenes can be exposed without supplementary lighting. The photograph of the show window (Fig. 1) was made by existing illumination. However, while scenes with high brightness ratios can be recorded on modern films, unfortunately even the softest printing papers are incapable of rendering both shadow and highlight detail from negatives of very high contrast. Nevertheless, it is possible to record this detail by special printing techniques or by photographing high contrast scenes with the aid of controlled supplementary lighting.

In an earlier paper ("Photographing Lighting Installations" — ILLUMINATING ENGINEERING, July 1952), the author suggested the reduction of high contrast through the use of subtle auxiliary floodlighting to soften the shadows without eliminating them. This brings the scene within the range of photographic film and paper while maintaining a faithful impression of the lighting installation. This paper also described the use of an exposure meter in measuring incident light to determine the

Figure 4. The letters on this sign are painted with a fluorescent material and illuminated with ultraviolet "black light." An ultraviolet absorbing filter must be used over the camera lens or the scene will appear as though it were floodlighted with white light. Exposure for this scene is determined by measuring the brightness of the letters. The letters in this sign measured 2.7 footlamberts. The exposure given was 25 seconds at lens stop f-16 on panchromatic film, ASA-100.

Figure 5. Using a brightness meter at the camera position the photographer obtained necessary exposure data to photograph the capitol dome. The dome brightness was 3 footlamberts; the shadow area was 0.03 footlambert. Exposure, 60 seconds, lens setting f-16 on panchromatic film ASA-100.

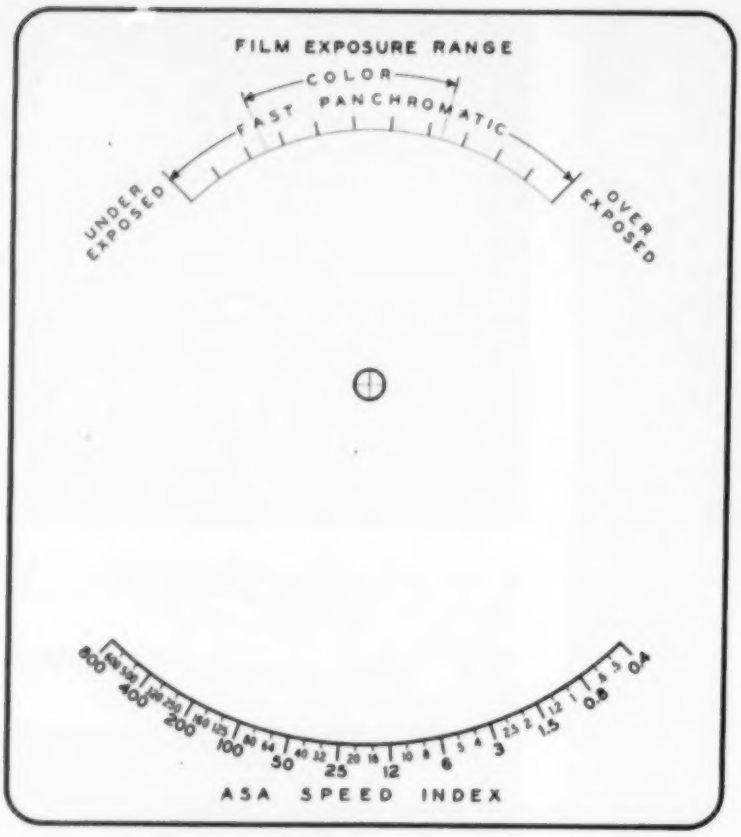
Figure 6. Exposure for this outdoor storage area was made with a brightness meter at the camera position. The brightness of the important shadow area was 0.2 footlambert. Exposure 20 seconds, lens setting f-22, film speed ASA-100.

diaphragm and shutter settings for lighting photographs. A nomogram was provided to permit exposure determination with a standard footcandle meter.

The exposures for the photographs in Figs. 2 and 3 were determined by the procedure described in this earlier article.

While incident light measurements can be used for the majority of lighting photographs, they are occasionally impossible to obtain — for example, when photographing lighted displays mounted well out of reach (Fig. 4), very dark or very bright instrument panels, or lighted streets. Exposures for these difficult-to-get-at scenes (Figs. 4, 5 and 6) can be based on *brightness* measurements made with the Luckiesh-Taylor Brightness Meter. In using this meter, the brightnesses of the darkest and brightest areas of the scene are read. Once these brightnesses are known, exposure data can be found through the use of the calculator shown in Fig. 8. The reader can construct such a calculator by mounting the unassembled components of Fig. 7 on lightweight cardboard and fastening them together with a paper rivet.

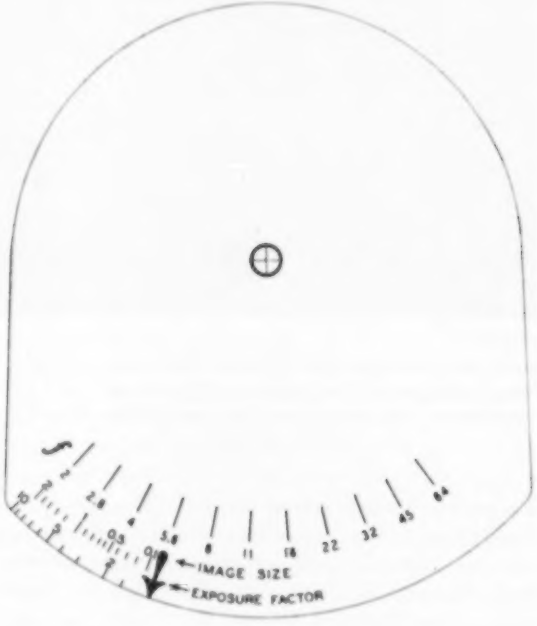
To use the exposure calculator, set the film speed index opposite the speed of the film being used. Next, rotate the circular dial until the measured brightness range (on the "Subject Brightness Range" scale) is centered on the "Film Exposure Range" scale at the top of the calculator. The exposure time now appears opposite any desired lens stop. Because of failure of the reciprocity law, some correction may be necessary when making extremely long exposures.



A

Figure 7. (left and below) Assemble this exposure calculator by pasting parts A, B and C onto a light-weight card and trimming. Assemble the three parts as in Fig. 8 (right) holding them in the center with a paper fastener.

Figure 8. (right) This exposure calculator is used to convert the brightness of selected scene elements into exposure time. To use, first set the index arrow at the selected film speed number on the ASA Speed Index scale. (For close-up photography the correct Exposure Factor number is set at the film Speed Index.) Next rotate the inner circular dial until the Subject Brightness Range (as measured with the brightness meter) is about centered on the Film Exposure Range scale at the top of this calculator. The correct exposure will now appear opposite any selected lens f-stop.



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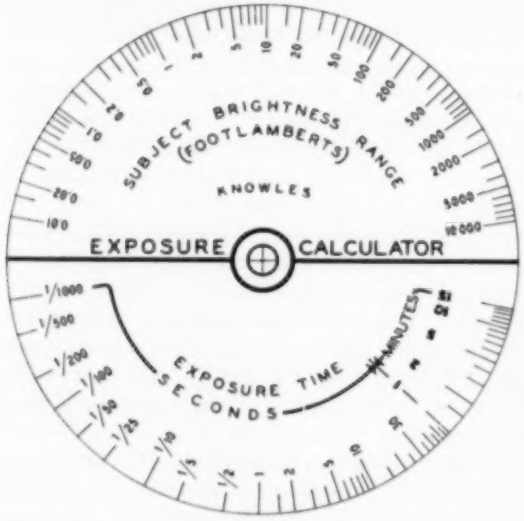

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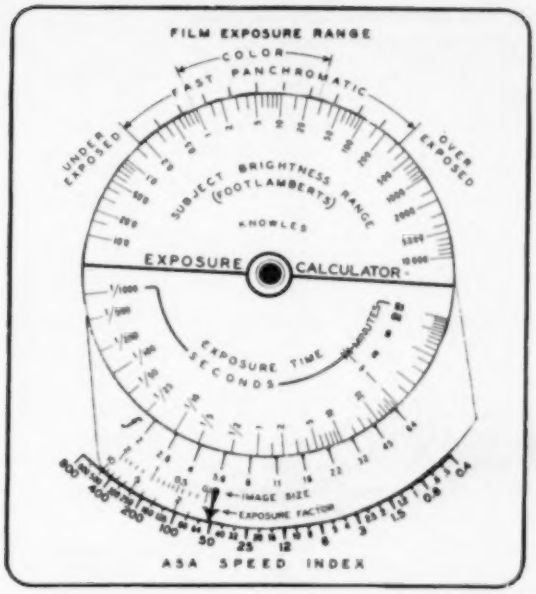

(This view of the exposure calculator has been reduced to about 72 per cent of its size as assembled from parts A, B and C on the facing page.)

With long scale, fast panchromatic films, the brightness setting may be placed at any position on the "Film Exposure Range" to produce either lighter or darker negatives.

If desirable, the exposure of a photograph determined by this method may be based on only one shadow or highlight reading rather than on the range of brightnesses described above. If a brightness reading in the shadow area is used, it should be set near the left hand end of the "Film Exposure Range." Conversely, when a highlight brightness reading is used, it should be set near the right hand end of this scale. For black and white photography, the exposure is usually based on the brightness of the darkest part of the scene in which detail must be recorded. In color photography the exposure is usually based on the highlight brightness.

Printing

The reflectance range of glossy printing paper is about 25-to-1. Negatives of scenes where the brightnesses are within this range will produce the most faithful prints from a brightness standpoint.

Since glossy printing paper will reproduce a contrast range no greater than about 25-to-1, special techniques are necessary to produce prints with acceptable shadow and highlight details from negatives of higher contrast than this. Negatives with contrasts of the order of 100-to-1 can be printed on very soft paper. While this tends to compress the middle gray tones, losing sparkle and crispness, some high contrast scenes, street lighting photographs for example, print quite well.

Many negatives of interior lighting will print well on medium-contrast paper except for the luminaires, which require more printing exposure than other portions of the negative. This additional exposure can be made with the use of masking tissues in a contact printer or through controlled dodging during projection printing. Special highlight contrast reducing masks can be used to advantage. Shading tissues and controlled dodging are also useful to hold back the occasional shadow area which prints out too dark. Another method of making contrasty negatives printable is by staining the shadow area.

Color

Color films commonly used for interior photography are designed for exposure under illuminants having a color temperature of 3200K. Photographic lamps of this color temperature are available for studio work, and when these are the only light sources used no compensating filters are required. The introduction of substantial quantities of light of other spectral composition, particularly that from fluorescent lamps, makes the use of color filters a necessity for the proper chromatic rendition of the scene.

Using Ektachrome Type "B" and Daylight Type film, developed according to the manufacturer's directions, the author photographed a test pattern of representative Munsell colors, tints and grays, under seven different "white" fluorescent lamps. After more than 300 trial exposures, color-compensating filters were selected for each type lamp to give results closely matching those obtained under 3200K tungsten illumination and Type "B" film. These choices, with the factor by which the exposure must be increased when they are used, are given in Table I.

Using the same seven types of "white" fluorescent lamps, the best combinations of color-compensating filters were determined for use with Daylight Type Ektachrome as shown in Table II.

Of the color films investigated Ektachrome Type "B" was selected as best for Deluxe warm white fluorescent lamps. Daylight Type Ektachrome was found to be equal or better for the remaining six types of fluorescent lamps tested for both color rendition and exposure required.

Because color rendition is affected by many things, including film freshness, age of developer,

TABLE I.—Results of Color Photography with Ektachrome Type "B" Film and Fluorescent Lamps Using Color Compensating Filters.

Fluorescent Lamp Color	Color Rendition without filters	Filters used	Exposure Factor	Color Rendition with filter
Deluxe Warm White	Fairly good (slightly bluish)	05M+10Y	none	Very good**
Deluxe Cool White	Poor (too blue)	20M+40Y	1.7	Good*
Standard Warm White	Poor (too blue)	25R+10Y	2.3	Good*
Standard Cool White	Poor (too blue)	40M+50Y +R10	3	Fair*
White	Poor (too blue)	30R+10Y	2.3	Good*
Soft White	Poor (too blue)	10R	1.4	Fair*
Daylight	Very poor (too blue)	15M+85B	3	Fair*

**Better use Type "B" film.
*Better use Daylight Type film.

TABLE II.—Results of Color Photography with Daylight Type Ektachrome Film and Fluorescent Lamps Using Color Compensating Filters.

Fluorescent Lamp Color	Color Rendition without filters	Filters used	Exposure Factor	Color Rendition with filter
Deluxe Warm White	Poor (too brown)	20C to 10B	2	Good**
Deluxe Cool White	Very good	none	none	Very good*
Standard Warm White	Fair (red cast)	10C	1.4	Good*
Standard Cool White	Fair (blue cast)	10R	1.4	Good*
White	Good	none	none	Good*
Soft White	Fair (red cast)	10C	1.5	Good*
Daylight	Poor (too blue)	40R	2	Good*

**Better use Type "B" film.
*Better use Daylight Type film.

condition of filters, and lamp operating characteristics, the filter selections above should be used only as a starting point in any discriminating color work.

Lighting installations having both filament and fluorescent lamps present a special problem to the color photographer. In general, these installations should be photographed by splitting the exposure into two parts. The filament lighting should be exposed without a filter, and the fluorescent lighting should be exposed with the appropriate color-compensating filter on the camera. This split-exposure method is not practical if people are included in the scene. Where the fluorescent lamps in such a combination installation are of the Deluxe Warm White color, the photograph can be made (on Type "B" Ektachrome film) in one exposure without filters with no serious color distortion.

Conclusion

The problems involved in producing good lighting photographs make it clear that they require a high degree of technical competence. By keeping in mind the above considerations, the amateur photographer of lighting installations may improve his chances for success, but the best insurance for obtaining top notch lighting photographs is the employment of an experienced photographer who can use the flexibility of the photographic process to compress the brightness contrasts of the lighting scene into the range of photographic materials, capturing an accurate visual impression in a realistic print.

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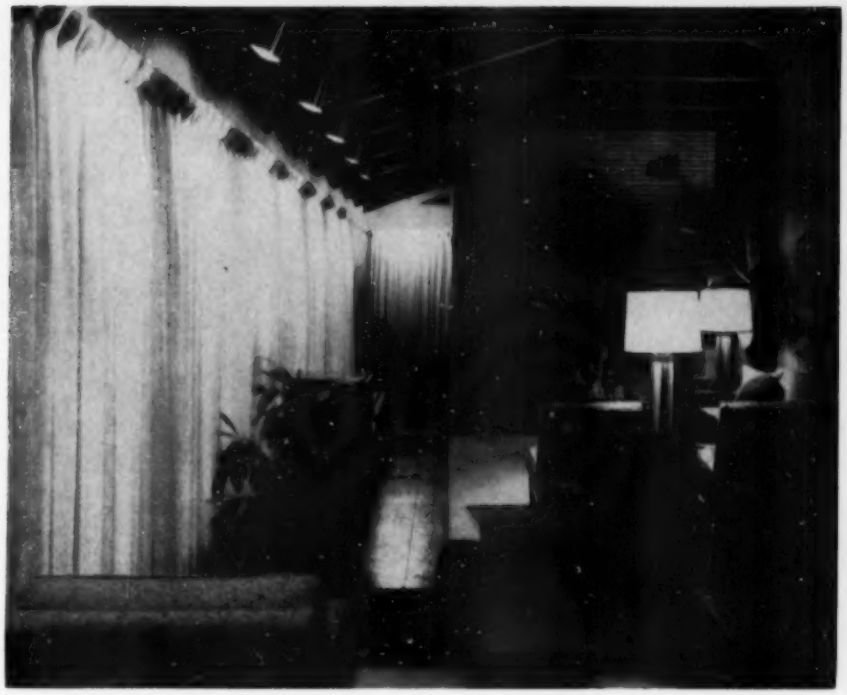

INSTALLATION AT BEVERLY HILLS, BLOOMFIELD, MICHIGAN.

Floodlighting Draperies

LIGHTING OBJECTIVE: To achieve an interesting decorative lighting effect on the draperies and to provide a means of comfortable general illumination in the room.

GENERAL INFORMATION: This informal 13 by 24 foot living room has a pitched beam ceiling that graduates from 8½ feet to 13 feet in height, with the exposed beams three feet apart. Ceiling and walls are of redwood (about 15% reflectance). One of the end walls is almost entirely covered by the light tan brick fireplace. Light beige draperies are of sheer translucent textured fabric having a 60% reflectance.

INSTALLATION: Seven bullet-shaped swivel reflectors are mounted on three-foot centers on the pitched ceiling, 18 inches out from the wall. Each reflector is equipped with a 75-watt R-30 flood lamp and aimed 30 degrees from the vertical to direct the light down on the draperies. The reflectors are finished in satin gold which blends very inconspicuously with the redwood ceiling.

Other lighting in the room consists of two table lamps equipped with wide harps to accommodate 50/100/150-watt R-40 lamps, plus a 300-watt CLM table lamp (removed when photograph was taken, because it was too prominent in the foreground).

The distribution of light on the draperies is very pleasing and more even in appearance to the eye than can be shown photographically. Brightness readings were taken, starting with the brightest spot from one of the center lamps, and then at the indicated heights above the floor, in line with this first reading.

Brightest spot (6' 10" above floor)	130 ft-L
4 feet above floor	60 ft-L
4 feet above floor	10 ft-L
2 feet above floor	5 ft-L

Lighting data submitted by Mary Taepke, Detroit Edison Company, Detroit, Michigan as one solution to this home lighting problem, and to suggest ideas which may be used in solving similar problems.

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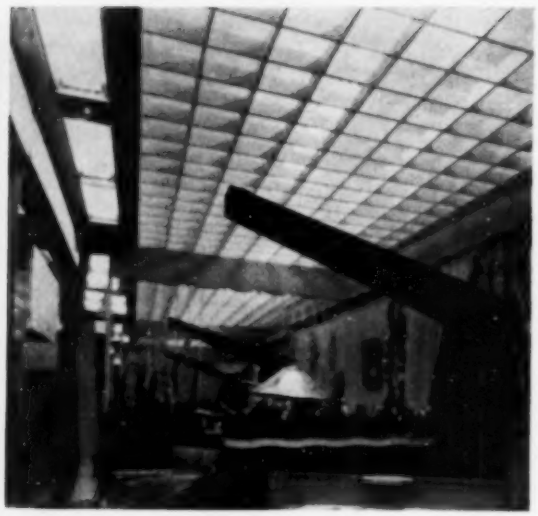


Direct lighting with a louverall ceiling and fluorescent and incandescent borderlights has been used in Woodhouse & Cie., Ltee., Quebec, Que., to supply 160 footcandles on the displays and minimize reflections on the glass windows. The show window ceiling consists of 12 square inch wooden louvers painted white, with standard cool white slimline lamps mounted above, 12′ from the floor. Bordering the plate glass window are 14 4-lamp luminaires using 40-watt cool white lamps, and 32 300-watt incandescent lamps. Area of the show windows is 66′ by 10′, with louverall ceiling height of 10′. Photo and data submitted by George Watters, Quebec Power Co.

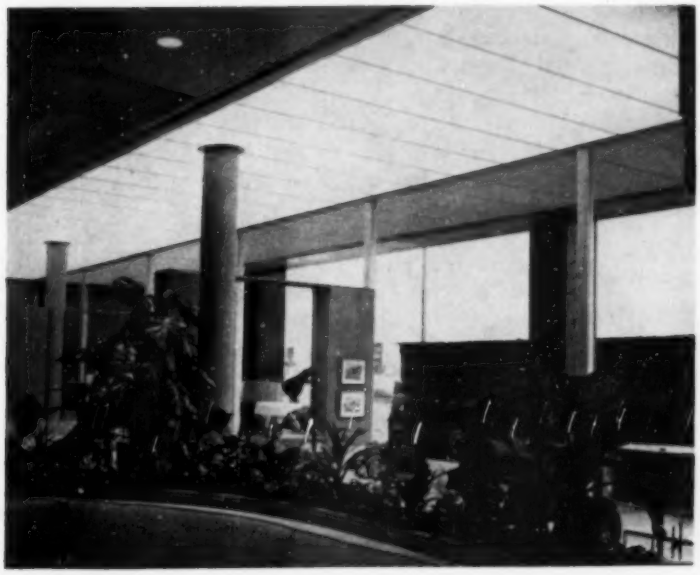
Show Window Lighting for Day and Night Display

A "see-through" show window, with a flexible lighting system, is a display feature of Kaufmans Dress Shop in Chicago. The recessed swivelled reflector lamps provide 200 footcandles on the show window to aid in minimizing reflections of the street in the plate glass. The units can be positioned for uniform window lighting or can be concentrated on individual displays, as desired. The ceiling extends out over the sidewalk in front of the store, reducing veiling glare from a bright sky. Recessed downlights in the projection provide supplementary illumination on the sidewalk at night. The show window ceiling at the front of the store is 10′ 6″ high; 12′ high immediately behind the window; and 14′ over the main part of the store. Photo and data submitted by Franklin Johnson, Commonwealth Edison Co., Chicago.

Lighting installations in store show windows aim at attractive eye-catching treatments for night-time display, with a minimum of reflected images from street during the day.

Located on the main street of downtown Buffalo, Chandler's Shoe Store (above right) requires high levels of illumination on the show windows, combined with good color rendition of the multi-colored merchandise. A level of 350 footcandles is achieved by the use of fluorescent lamps and incandescent show window reflectors, spots and floods — all equipment recessed. Lining the front of the show windows and the entranceway to the store, a total of 37 show window reflectors with 300-watt lamps are spaced approximately 16" on centers. Fifteen strategically placed adjustable spotlights with 200-watt PAR-46 lamps highlight specific displays. At the rear of the street-front windows, 15 reflector units on 18" centers use 200-watt lamps.

A total of 8 fluorescent troffers, each with 6 36" or 48" lamps, have diffusing glass panels with photographically etched louvers giving 45-degree cut-off. Two downlights with 150-watt R40 reflector floodlamps are used in the entrance way, and one is located in a 3-foot-square cut-out of the street-front window. Photo and data submitted by B. F. Lyth, Jr., Niagara Mohawk Power Corp., Buffalo.



Display windows rising directly up to the ceiling level at the new John M. Smyth Co. furniture store, Chicago, created a problem of achieving high illumination to attract attention to the display without reflected glare. A louverall ceiling, of molded styrene louver panels with 1" x 1½" apertures providing 45 to 35 degrees cut-off, supplies 55 footcandles. "T" frames, 2 feet apart and 9'6" long, support the individual sections of the molded louvers, which are lifted from the frame for maintenance. Rapid Start fluorescent lamps are flush mounted on the ceiling on 2'3" centers. The louver panels are dropped 2'6" from the ceiling. The complete installation covers 1140 square feet. Architect and Electrical Engineer was L. P. Summarkoff, Chicago. Photo and data courtesy Electro Silv-A-King Corp., Chicago.

One of a series of articles on the characteristics of materials used in the lighting industry, prepared by an illuminating engineer whose specialized work is in the glass industry.

Controlling

Characteristics of Lighting Glassware

By A. R. JAEGER

GLASS is one of the materials fabricated by ancient man. Its origin is obscure, but we know that very early in history our ancestors learned to fashion it into useful and decorative articles.

Only in modern times, however, has research into the chemical and physical properties of glass developed it into an engineered, and engineering, material. In this country glass research began more than 50 years ago. An early problem was standardization of the colors of glassware used in railway signaling. At that time the lack of uniformity in those colors was the cause of considerable confusion in railway operation.

Properties of Glass

In discussing the characteristics of lighting glassware we probably should start with the properties of glass in general, for those properties must necessarily be the foundation for all uses of glass.

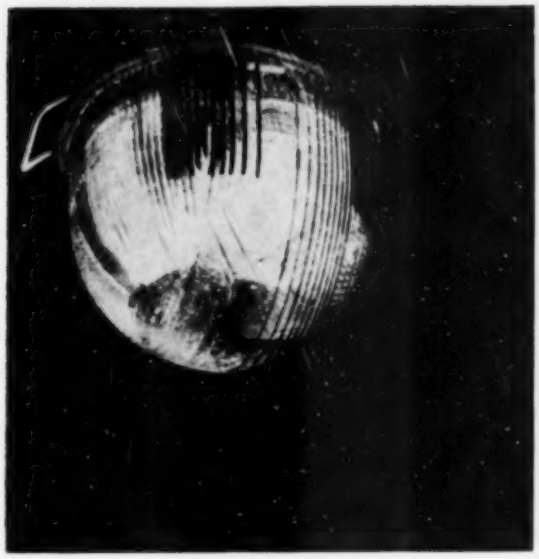
Chemically, glass in a mixture of silica (SiO_2), a pure sand, with other metallic oxides. Ingredients commonly used in glass formulae include soda (Na_2O), lime (CaO), magnesia (MgO), alumina (Al_2O_3), lead oxide (PbO), boron oxide (B_2O_3), and others. It is by the precise control of these and other ingredients, and by heat treatment or other processing of the glass after fabrication, that the special properties of the various kinds of glass are produced.

Physically, glass is a non-crystalline substance that might be accurately described as a supercooled liquid. It is rigid at ordinary temperatures, and becomes soft, or even almost fluid, at higher temperatures, but it has no definite melting point in between.

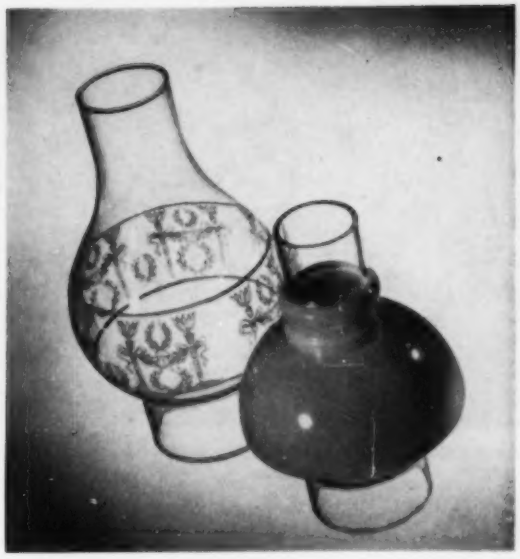
Glass is commonly thought of as a brittle and fragile material, but this concept is a narrow one that does not give consideration to some of its most important qualities. For glass is perfectly elastic—that is, it can not be permanently deformed. It yields to stress, but always returns to its original shape when the stress is removed.

Glass has very high strength under shear or compression. Its intrinsic tensile strength is also exceedingly high (glass fibers have supported tensile stresses of more than 1,000,000 psi). When glass breaks it usually is the result of scratches or

AUTHOR: Illuminating Engineer, Corning Glass Works, Corning, N. Y.



Protective



Decorative

other localized surface areas being placed into extreme tensile stress.

The thermal expansion characteristics of most glasses are similar to those of the ordinary metals, usually being somewhat lower. In the mounting and framing of lenses and panels some allowance is normally made for expansion. The heat conductivity of glass is quite low. Consequently temperature differentials across a piece of glass cause unequal expansion in portions of the piece. Stresses resulting from such temperature differentials can be of considerable magnitude, and may cause breakage of ordinary glass. This characteristic is eliminated in "heat-resistant" glasses, either tempered or having thermal expansions which are inherently low.

Electrically, glass is a non-conductor. Unlike some dielectric materials, or non-conductors, however, glass will not easily take on an electrostatic charge, and does not attract dust.

Mechanically, glass has high dimensional stability. It won't warp, shrink, stretch, or sag, and will withstand much higher temperatures than organic materials. It is highly resistant to weathering and chemical attack, and will not deteriorate with age in any normal application. Glass is amenable to a variety of manufacturing processes, for it can be blown, pressed, rolled or drawn. It can be worked, and can be finished by any of a number of methods.

Optically, glass is a medium that performs three important functions. Clear glass as a refracting material can be shaped into lenses to direct and focus light. Its refractive index can be varied over a fairly wide range by control of its composition. It also can be made a diffusing medium, or a color filter.

Types of Lighting Glassware

Glass performs three principal functions in lighting: 1) Control of illumination; 2) protection of the light source, and 3) decoration. In many installations two, or all three, of these functions are combined. The kind of glass used in any specific application will depend, of course, on the functions it is to serve.

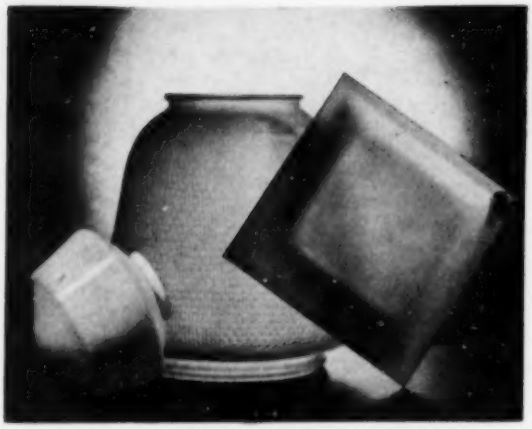
There are four general type of glassware used in lighting. They are:

1. Crystal — a term that now is widely applied to any clear glass.
2. Opal — a translucent glass which diffuses light.
3. Heat Resistant — glass having the optical characteristics of one of the three other types, but considered separately because of its physical characteristic of resistance to thermal shock.
4. Colored Glass.

Crystal Glass

Where direct transmission of light is desired, either with or without directional control, and where heat is no problem, crystal glass is commonly used. It usually is the least expensive of glasses although refinements now are commonly made to achieve better color, or other desired physical char-

Some examples of products made in clear crystal lighting glassware.



Some interior and street lighting pieces made of opal diffusing glass.

acteristics. Crystal glass is easily worked. Examples of globes, panels and other crystal elements are known to everyone familiar with lighting.

For positive directional control, where either concentration of illumination, or control of fixture brightness is wanted, crystal can easily be made in shapes that achieve the desired results. Lenses or panels of the fresnel type, or of other prismatic designs, are common examples of such applications. Street lighting refractor globes also represent carefully engineered designs in prismatic glassware. The refractive index, a measure of the light-bending power of a glass, must be closely controlled in crystals used for lenses.

Crystal glasses having surface configurations, such as fluting or pebbling, are used to shield luminaires and diffuse the light. These configurations are impressed into the glass surface during rolling or moulding operations, by applying the pattern to the forming surface in reverse contour from what is desired on the glass. A wide variety of surface treatments including sandblasting, etching and enameling are also used to achieve various degrees of light diffusion and decorative effect.

Opal Glass

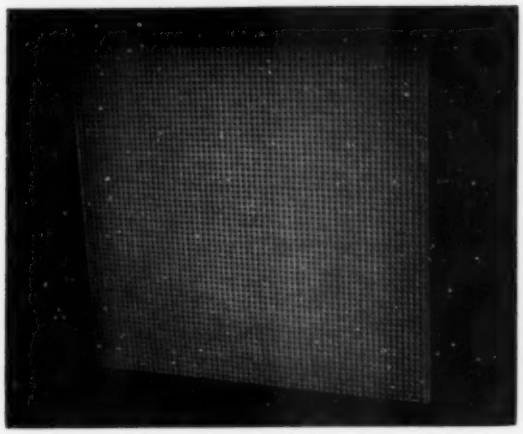
Opal glass usually is the preferred diffusing medium, where uniformity of illumination and freedom from shadows are desired. Its advantages over surface treated diffusing glasses lie in improved appearance, higher efficiency and ease of cleaning.

Most opal glasses contain microscopic or larger particles suspended within the structure of the glass itself. These are colorless, non-metallic crystalline particles with indexes of refraction which differ from the base transparent glass. The opal or milky effect is imparted by multiple scattering of light within the glass. Since the crystals scatter the light with perfect optical efficiency, opal glass is an effective means of achieving diffusion. To produce such internal crystals, special ingredients are added to the glass batch. These generally are fluorides, sulphates, phosphates, chlorides, or oxides of tin, antimony, and a few other metals. By selection of the batch materials and regulation of the temperature conditions during forming, the size and concentration of the crystals, and therefore the proportions of light transmission and reflection of the glass, can be accurately controlled.

All diffusing materials, including opal glasses have unique advantages for lighting. A diffusing globe or panel, by intercepting light and redirecting it, becomes in itself a secondary light source of larger area. This softens shadows, and causes the eye to focus on the luminous globe or panel, rather than to look through it. The diffusing element offers distinct advantages in the design of luminaires, since all parts of the unit behind it are concealed from direct or reflected view.

Enclosing globes of opal glass for interior incandescent lighting installations are familiar examples of this type of diffusing element. For many years they were the standard method of obtaining uniform illumination, and of reducing brightness contrast. Ornamental street lighting globes are also made of light opal glasses.

In fluorescent installations, panels of opal glass are commonly used for brightness control and light diffusion. As the glass panels are normally the determining feature in the appearance of the fluorescent luminaire, they are often made with decorative surface patterns, and in bent shapes to conform with fixture styling.



Louvered glass, having partial direct transmission and partial diffusion.

All diffusing media, including opal glasses, have a reflected component — that is, part of the incident light is scattered back in the direction of the light source. Thus, diffusing elements are especially useful in suspended luminaires for achieving semi-direct and semi-indirect types of light distribution.

Glasses which have partial diffusion may be used where some of the light is to be transmitted directly, and some diffused. Globes in which the bottom portion is opal, while the top portion is clear, provide diffusion of all illumination below the horizontal, while direct and reflected light above the horizontal is transmitted directly upward.

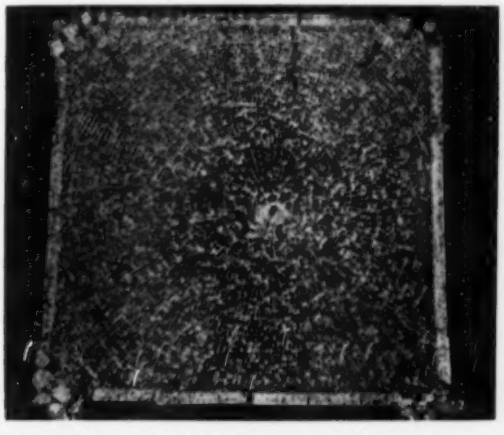
Another medium which makes possible a combination of direct and diffused lighting is photosensitive glass. White opal areas may be produced in clear glass of special composition by a process similar to photography. Exposure to ultraviolet light changes the form of silver ions in the glass so that upon subsequent heating each of these particles becomes a nucleus for the growth of crystals. The exposed areas become translucent white through the whole thickness of the glass, while areas to be left clear may be shielded by a negative. Lighting glassware is now made in an egg-crate pattern of white opal louvers integral in the glass panel. The pattern of louvers is so designed that light incident at angles of less than 45 degrees from vertical is transmitted directly, while light at greater angles is diffused. In a variation of this design the opal louvers are tilted at an angle of 30 degrees.

Heat Resistant Glass

Wherever thermal stresses are expected, as in many incandescent lighting installations, and in most outdoor applications, the glass elements should be heat resistant. As explained above, sudden temperature changes across a piece of glassware produce severe stresses. However, those stresses are greatly reduced in "borosilicate" glasses. Boric oxide, replacing lime and soda as a flux to help in melting the silica, combines with the other materials in the batch mixture in such a way as to produce a glass having a coefficient of expansion only 35 per cent to 40 per cent of that of most crystal glasses. Thus a temperature differential that will produce a given stress on the surface of a piece of ordinary soda-lime crystal will result in a reduction of stress on a piece of borosilicate glass in that proportion.

This kind of heat-resistant glass is used especially in lenses and panels of the Fresnel type for high-wattage incandescent installations, and for outdoor applications both in the illumination and signaling fields.

Several types of prismatic lighting lenses, usually made in heat-resistant glass.



Characteristic "dicing" of tempered glass, into small harmless fragments, when strength limit is exceeded.

Most types of glass also can be made shock resistant by tempering. This process is essentially a heating and chilling operation. Its effect is to create protective compressive stresses in the surface of the glass which resist tensile stresses that otherwise might fracture it.

The increase in performance of tempered glass is equally effective in the case of thermal and mechanical stresses, so it is useful in protecting lighting equipment wherever either sudden temperature changes, or impact, are hazards. When the limit of strength is exceeded, tempered glass "dices" into small harmless fragments, a secondary characteristic of this material which makes it valuable for transportation and institutional lighting fields. Examples of such installations can be found in explosion-proof globes, side-lights and panels for industrial locations, and lighting installations in jails or mental institutions.

Color Filtering Action of Glass

Not only does glass provide directional control of illumination, but it offers a method of color control as well. Glasses can be made that perform any light filtering action desired, from the virtual lack of absorption of the purest crystal, to complete opacity. This capability covers not only the visible spectrum, but extends well into the infrared and ultraviolet as well. And since any color filtering action is an integral property of the glass, it is permanent.

Applications of colored glass have been greatly increased in recent years, but are naturally limited to specialized purposes. They include such uses as stage and display lighting, railroad and marine signaling, aircraft and automotive lights, obstruction markers, and the like.

Glass with color-filtering properties is produced by adding metallic oxides to the batch of raw materials. For some colors the melting process releases the metallic ions into the glass solution, giving it their characteristic color. Blue glass is made by adding cobalt, green by adding copper or chromium and amber by adding nickel.

Other colors are obtained through metallic particles or colloidal particles in suspension. Heat treatment of a glass, after fabrication, also may affect its color. Red glass, for example, has but slight color when it is formed, but becomes more dense in a carefully controlled heat treatment.

It is advisable to give careful consideration to the spectral transmission characteristics of the glass in ordinary lighting installations, so that the color of the light source is not distorted. Unless it is compounded with great care, glass is likely to show a slightly bluish-green hue — noticeable when viewed edgewise — as a result of iron contamination of the batch. In order to produce water-clear glass completely devoid of any color-filtering action it has been found necessary to use special iron-free ingredients, and to take elaborate precautions to avoid iron parts in the tools and containers used in handling the batch materials. The use of "water-white" lighting crystal is particularly important with fluorescent sources, which are themselves deficient in the red end of the spectrum, and where the selective absorption of the greenish glass would further weaken the warm colors.

Decorative Glass in Illumination

Decorative uses of glass in lighting installations usually are combined with other functions served by the glass. That is, globes, panels, or other elements serving primarily to direct, diffuse, color, or otherwise control the light, may at the same time be made in decorative shapes, or bear decorative designs, that are not incompatible with their primary functions.

The great variety of types of glass available, and the many decorative and finishing treatments that may be used on glass, make it possible to achieve virtually any kind of decorative effect desired.

Ceramic enamels can be applied in intricate patterns. Since those enamels are themselves glasses, and are fused with the supporting element, they are permanent in every respect.

Surface patterns can be etched with acid, sandblasted, or ground on any glass element. Acid etching produces a surface that is somewhat finer and softer in texture than sandblasting, but the two finishes are closely similar. Some decorative techniques weaken the surface of the glass, and care must be employed where glass elements serve protective functions.

The fact that glass is a mixture, rather than a specific chemical compound, makes it capable of almost infinite variation. Thousands of formulae for glass have been used, each of which produces a glass with unique characteristics. Thus glass can be engineered to satisfy any combination of requirements in the field of illumination.

[EDITOR'S NOTE: This article is one of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree Waite Baked Enamel Finishes," February 1953; "Characteristics of Alzak Aluminum," March 1953; "UL — and the Lighting Industry," July 1953; "Characteristics of Tungsten," August 1953; "Calculating Sound-Absorbing Effect of Acoustical Baffles in Lighting Systems," September 1953; "Characteristics of Phosphors," May 1954.]

INSTALLATION AT UNIVERSITY OF PITTSBURGH.

Lighting a University Field House

LIGHTING OBJECTIVE: To provide flexible lighting for a modern university multi-purpose athletic area.

GENERAL INFORMATION: The new Pitt Field House is a typical multi-purpose athletic area. The large floor area, which is equipped with removable basketball floor and bleacher sections, is used for baseball practice, football practice, track meets, basketball, district championship play-offs and the like as well as many intramural sporting events. This variety of activities requires a flexible lighting system.

The room has seating capacity for 5500 people. Surface characteristics are as follows:

ceiling	Acousti-Celotex painted cream	46% RF
walls	concrete block painted green	29% RF
playing floor	natural wood	27-38% RF
surrounding floor	clay	17% RF

INSTALLATION: Over the first floor main area, 40 footcandles of maintained general illumination is provided by 120 Westinghouse Millites using 1000-watt filament lamps in pairs spaced on 25 x 25 foot centers. Mounting heights of these units vary from 35 feet at the sides to 50 feet at the center of the arena. When the basketball floor is assembled in the center of the gym area, an additional 28 Millite units are energized to bring the illumination level over the playing court to between 60 and 70 footcandles. Brightnesses are shown in Fig. 2.

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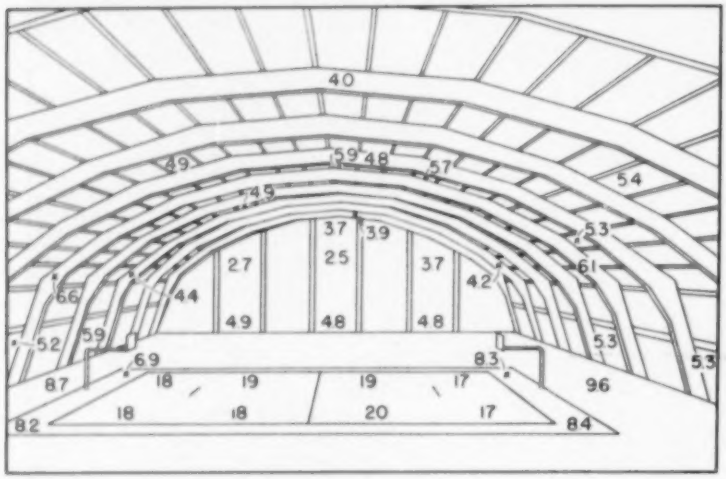

Figure 2. Brightnesses in footlamberts measured from top of grandstand.

To protect the large crowds which attend these sporting events against possible panic and confusion due to an emergency power failure, a separately supplied circuit of ten 300-watt filament lamps in Westinghouse Millites is installed. These units as well as the exit and stair lighting luminaires are served from a gas engine generator.

As with all large areas where high mounting heights are involved, maintenance of the lighting equipment is a serious problem. The lighting unit used in this installation has an impact resisting glass cover and is completely sealed with an asbestos gasket to minimize dirt collection. The luminaires are installed on tandem brackets on Thompson lowering hangers to permit servicing of the units at floor level.

Architects: Ingham, Boyd and Pratt; consulting engineer: E. T. Wiesman; electrical contractor: Sargent Electric Company — all of Pittsburgh.

Lighting data submitted by A. G. Caplan, Duquesne Light Company, Pittsburgh, Pa., as an illustration of good lighting practice and to aid in the design of similar installations.

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A Photometric Laboratory For Today's Light Sources

By KURT FRANCK
R. L. SMITH

THE distribution photometer for incandescent lamps and luminaires has served for an extended period of time with little change in construction. Simple and universal in method of operation, it could be operated either in vertical or horizontal position with equally high degree of accuracy. We have had few problems in the testing of incandescent sources.

However, the fluorescent and mercury lamps brought forth several inherent characteristics of gaseous sources which upset testing procedures. Large sources, sensitive both to temperature and position while under test, could not be accurately explored on the simple type photometer. These problems demanded a careful review of the fundamental photometric theory and how it might be adapted to construct accurate measuring devices for these hard-to-handle sources. The findings provided us with a basis for specifications of a new photometer for these newer light sources.

We desired the greater test distance to be an actual, direct distance, not reflected by devices which are subject to change with consequent error. Interrelated with sufficient test distance is the proper positioning of the gaseous sources during test. Since the output of these lamps changes with position we felt that they should be tested in the same position as that in which they are used in order to get accurate results.

The gradual increase in size of street luminaires has also concerned us. Newer prismatic refractor designs redirect the light from the reflector both laterally and vertically. The optical center appears to shift within the unit, *i.e.*, the rays of light appear to emanate from a part of the glass refractor several inches below the light center. This apparent optical center shifts more with increase in the vertical angle. If the point of rotation is the light center, then the apparent angle of emanation at 25 feet or 30 feet mounting height at angle of maximum candlepower may be 2½ to 3 degrees higher than the angle measured on a photometer with a short test distance of 10 feet. The parallax can be corrected by tedious mathematical calculation. However, when the test distance is increased to 25 feet, the difference is cut to one-half degree and may be further reduced by rotating about an assumed optical center below the actual light center. A longer test distance eliminates the need for correction factors and gives candlepower data on the luminaire at distances comparable with actual mounting heights.

Without a large room it is difficult to handle these two closely related specifications. Various expedients have been suggested during the past few years, all of which permit possible sources of error and entail use of correction factors. To get a photometric dark room that would meet the specifications already set forth, we found that it would have to be newly built. It was incorporated as a part of our new engineering center.

In a room of such large proportions it would be practically impossible to operate manually the photometer to meet our above requirements. A general plan resulted in which the construction was to be mechanically controlled from one central point. A natural outgrowth of this idea was to remove the photometrist from the dark room and place him in a central control room in comfortable light surrounds from which he could operate the photometer.

One other consideration which affected the design of our photometer was the general type of distribution that we measure. Since for the most part our fixtures fall either in the direct or semi-direct we could modify the vertical angular range. We decided that a range between 0 and 110 degrees from nadir will take care of most of our work. Those units which do have a small percentage output in the 90-180 degrees zone may be inverted in trunnions for photometric explorations between 110 degrees and 180 degrees by taking readings in the inverted position between 70 to 0 degrees.

The dark room built to house our proposed photometer towers above the remaining engineering center. With the floor at basement level, the roof stands at a level 35 feet above it. To allow for full swing of long fixtures being tested a length and width of 32 by 15 feet were found ample. At the

AUTHORS: Holophane Company, Inc., Engineering Center, Newark, Ohio.

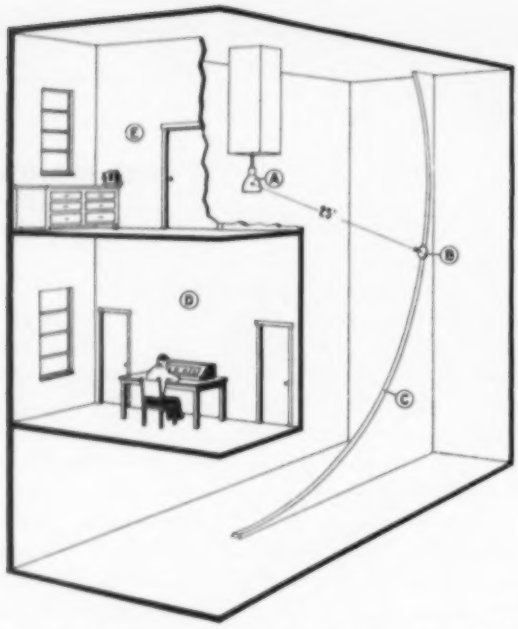


Figure 1. Diagrammatic view of photometric testing laboratory.

A — Lighting unit on test.
B — Photoelectric test cell.
C — Test cell track, 25-foot radius.
D — Test control room.
E — Work shop.

first floor level at one end of the dark room the control room (8 by 15 feet) is situated. Above it is located a workshop of the same size for making test equipment.

Before going into a detailed description of the individual parts, a quick look at the entire picture is in order. The line drawing (Fig. 1) diagrams the locations of the major assemblies. The steel circular arc represents the locus of the photocell positions. The vertical rotator near the ceiling supports the luminaire, its light center being set at the center of the arc. From a door in the work shop, the photometrist may service the fixture under test by means of a platform which can be rolled out from under the work shop floor. The photometer room is painted flat black to reduce reflections to a minimum. From the control room the photometrist is able to operate the equipment in the dark room.

In detail the steel arc was constructed in three steps. Heavy angle iron members forming the skeleton or framework of the arc were first placed in one plane which represents the vertical plane of test. These angular beams were arranged in triangular, bridge-like formation to give rigid support to the final arc. On this structure, which was mounted on the floor and the end wall opposite the control room and workshop, another L-shaped angular strip was bolted. Before actually fastened, this angle iron was cut at equal distances of 2½ degrees chord lengths and bent. These chord lengths formed the sides of a regular polygon that circumscribes the final 25-foot arc. On this plane, regular-polygon truss rests 4 inches by ⅛-inch strap iron. It assumes of its own weight the final arc shape and acts as a flat, ribbon-like, circular track for a small four wheeled cable car which carries the photocell. The grooved wheels whose axles are perpendicular to the track engage it edgewise.

Located on a circular centerline whose radius is several inches larger than the track radius are a series of pulley wheels spaced at 2½-degree intervals. Aircraft steel cable strung on these pulleys operates to pull the cell cable car up and down the track. About halfway up the track and a little back of it a windlass winds up one end of the cable while it unwinds the other, the slack in it being compensated for by a weighted pulley. One revolution of the windlass drum moves the cell car five degrees on the arc track. A small d-c motor operating from a rectified source turns the drum slowly giving the cell car a speed of one-half degree per second, or a distance of a little more than 2½ inches on the arc per second. Geared to the drum are two Selsyn indicators, one to give major change in position of cell car, the other, a vernier, to give minor change. A second set of Selsyns located in the control room and connected to the ones on the arc follow closely their movement and accurately indicate the angular position of the cell. We can check these positions to one-tenth of a degree.

We use a two-inch selenium barrier-layer cell for most of our photometric work. To maintain linearity of response, illumination levels on the cell are limited to seven footcandles. To accomplish this, neutral filters of different densities may be interposed between cell and test luminaire to reduce the values to within the limited range. The filters are mounted on a circular disc containing six openings spaced 60 degrees apart. One opening is without a filter; the other five contain filters having nominal multiplying factors of 2, 4, 10, 20 and 40. The one of proper density may be rotated to operating position by a small d-c motor geared to the disc and operated by push buttons from the control room. Knowledge of which filter is in front of the cell is shown on the control panel by Selsyn indicators.

Although the filters are called "neutral" we have found that their selectivity varies with the light

source being measured. Accordingly we calibrate each filter for the source under test.

The usual precautions are taken to shield extraneous light from the cell by providing it with a conical shield blackened with flock. The walls directly opposite the cell are covered with black velvet drapes.

Adequate stairs and runways connect the three rooms such that they are readily accessible.

The vertical rotator which supports the luminaire at the center of the arc consists of two major parts, a stationary structure and an elevator. The stationary part, bolted to roof beams, acts as a guide for the elevator portion. As the light center position varies from fixture to fixture, the elevator is moved to compensate for the difference. In the stationary part a steel square plate is fastened to the roof structure. At each corner 28-inch long pieces of pipe are welded at right angles to it. A steel square bottom plate is also welded to these pipes, which act as guides for four steel rods of the elevator. To insure close guidance, the pipes are bushed with brass at each end to tolerances which just permit nice movement of the steel rods. The four rods of equal length pass through the bushed pipes and are bolted to steel plates at top and bottom. Throughout welded-in gussets maintain squareness and plumbness of the two structures.

Four screw jacks raise or lower the heavy elevator within the bushed pipes of the stationary guide to place the light center at the arc center. The four jacks located at the corners of the bottom plate operate simultaneously and thereby maintain the bottom plate in level position.

The bottom plate of the elevator is provided with ball races above and below upon which is carried by ball-bearings an annular ring with outer diameter of 16 inches and inner diameter of 8 inches. Asymmetric units such as street lighting and fluorescent luminaires hang from this annular ring.

Floating on bearing raceways in the annular ring is a smaller ring. The lower face of this ring, slightly less than 8 inches diameter, protrudes through the 8-inch hole in the larger ring and is flush with the bottom face of it. Symmetric units are supported from this face plate.

A 2½-inch hole in the small annular ring allows the lamp socket to enter the fixture vertically. The lamp revolves at 50 rpm to give average readings and the luminaire mounted on the face plate of the small ring may rotate at the same speed.

A stainless steel tubular shaft supports the lamp socket at one end. Being hollow, it carries the ground side of the current to the socket shell while an insulated brass rod through the tube carries the "hot" side to the socket contact. The current is supplied at the top of the shaft by means of rotating conductors in mercury cups. This permits current flow to the rotating shaft.

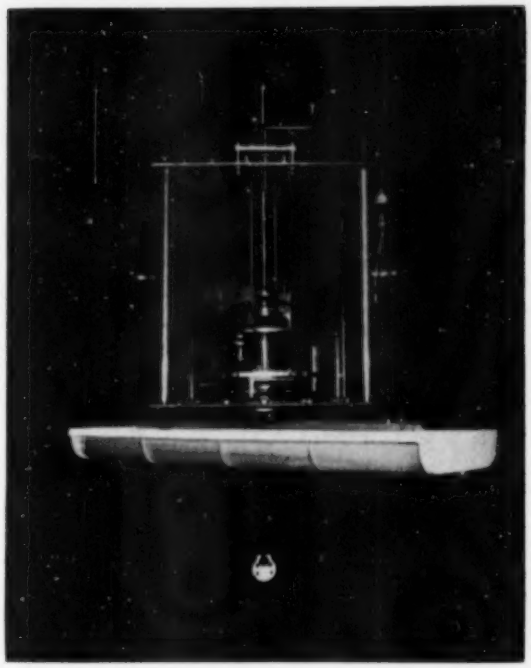


Figure 2. Mechanism of the vertical rotator.

The socket shaft revolves in two ball bearings spaced to give rigid support and to keep it plumb. A small gear motor connected by belt to a pulley on the shaft rotates the lamp. A clamp above the pulley may be released to move the light center to proper position.

The photo, Fig. 2, shows the intricate mechanism of the vertical rotator. Most of it is for the control and rotation of the large annular ring used for testing asymmetric fixtures. A small d-c motor operates a large gear fastened to the annular ring. This revolves the ring at a speed of one-third rpm which allows very careful exploration of asymmetric reflectors and refractors.

Direct-current motors are used on all of the controls as they may be started and stopped quickly and may be reversed very easily by reversal of armature windings. The motor circuit shown in Fig. 3 is rather interesting. Two momentary push buttons are used, one to give clockwise, the other counterclockwise motion. These are of the type: push to make one circuit and break the other circuit. When neither button is pushed or both are pushed, the two push button circuits short the

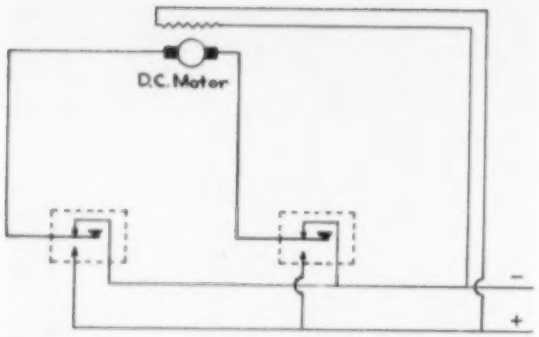


Figure 3. D-c motor circuit to produce forward or reverse motion.

armature. Since the field is in the circuit all the time during the test, the shorted armature in its field acts as a magnetic brake. Pushing one button carries the positive current to one side of the armature; pushing the other reverses this, thereby reversing the direction of rotation. This circuit makes for rapid stopping, starting and reversing of the motor and facilitates return to a position if it be slightly overrun.

One Selsyn indicator in the annular-ring assembly revolves $^1/_{36}$ of a turn for every 10-degree movement of the ring, while a second Selsyn is geared to the first one to make one complete revolution each 10 degrees of the annular ring. The first measures roughly the angle, while the latter one enlarges the change of the first, thereby acting as a vernier. The response of the two Selsyns is coupled to a similar pair in the control room which follows closely giving true indications of the lateral orientation of the luminaire. Single degrees are marked on the control panel and tenths of degrees can be readily estimated. It is to be noted that throughout we use d-c motors for rotating each device and not Selsyns. The latter are used only as indicators.

There are occasions when we desire to read lamps alone on a horizontal photometer. Such equipment is also handy for testing small units where candlepower data from 0-180 degrees are desired. Consequently we developed a horizontal rotator that may be connected readily to the vertical rotator. The main body of it is bolted to the annular ring of the vertical rotator. A plate-pulley on the horizontal one is fastened to the face plate of the vertical, thereby conveying the power to rotate the lamp from one to the other.

The horizontal shaft is set to 0 degree by lining it up with the steel arc. The cell car is then raised vertically to the 90-degree position on the arc. The horizontal shaft is elevated by the four jacks until its centerline is 25 feet from 0 degree on the arc. It is then in position for test and is used as any typical horizontal photometer. The Selsyns indicating lateral angles of the annular plate now indicate the vertical angle of the lamp. A lamp may be read in this manner from 0-180 degrees to get candlepower values for lumen computations. Again, power is fed to the lamp by contacts in mercury cups. This accessory, horizontal rotator has proved to be very useful.

Temperature differences in various parts of a room this large can be troublesome. We have special equipment built into our heating system that, while not strictly air conditioning, equalizes the temperature from top to bottom of the laboratory.

The control room is located adjacent to the photometer dark room. In well-lighted surrounds, the photometrist conducts the test in the same type of environment as that in which engineers and office workers live. His eyes no longer are subjected to the severe task of trying to read meters in a room with such sharp contrasts as high unit brightness against black walls found in the old type photometric room.

This is not the only desirable feature. Some design engineers are human in that they desire to know the "returns" on their latest designed unit before the "votes" are all in. They may come into the control room to see if the angle of maximum candlepower of a newly designed luminaire shows up photometrically at the angle for which they designed it. This too saves on test time, for it enables them to see changes in distribution which indicate what should be tested next.

The electrical cables carrying Selsyn currents, cell currents and d-c motor currents all merge into this room and flow into the control panel. This panel like a large part of the other equipment was designed and built in our own laboratory.

The photo in Fig. 4 shows the control panel. The knob at the left gives major voltage control while the one at the extreme right is for minor or vernier voltage control. The type of lamp dictates whether voltage, current or wattage shall be measured. The required instrument is plugged in jacks on the table. Constant voltage transformers mounted under the control panel are source of supply.

Between the voltage control knobs, the two dials at the left indicate rough and vernier location of the cell on the track; the two at the right give rough and vernier lateral orientation of a vertically mounted asymmetric unit. A small dial in the center indicates the density of the filter that is in front of the cell.

Figure 4. Control panel. With a central control room, photometrist sits in pleasant light surrounds and cheerful atmosphere.

In the testing of asymmetric units there is the problem of getting the lateral orientation set properly before starting the test. To do this the photometrist selects two defining points that establish the axis of symmetry of the luminaire. In the case of a refractor he takes one plane that is well defined by the prism structure or if an asymmetric reflector alone, the axis of symmetry. On a reflector he drills two small holes diametrically opposite on this axis. After the reflector is placed on the vertical rotator and otherwise lined up, he sights through the holes and by a second set of lateral push buttons at the vertical rotator, he revolves the reflector one way and then the other until he can sight the centerline of the arc. This is facilitated by a pin-point light bulb which may be lighted for this purpose at the centerline of the arc at 90 degrees vertically. After the unit has been properly oriented at the vertical rotator, the photometrist goes to the control room to line up the pointers on the two lateral dials. This is accomplished by a gear arrangement for shifting the Selsyn stators, thereby allowing the photometrist to "zero" the pointers.

With the equipment described above the photometrist has control of the test at his finger tips. To raise the cell on the arc he pushes one "Vertical" button, to lower it he pushes the other. Likewise two buttons control respectively clockwise and counterclockwise motion of asymmetric type units under test. When illumination levels on the cell become too great as indicated by the microammeter used to read the test, one button will rotate a heavier filter in front of the cell while another will change to lighter density. These six buttons are mounted on a small switch board, measuring 4 inches by 6 inches. The switch board is connected by extension cable to the control panel so that it may be moved to the spot most convenient for the photometrist.

To read a vertical distribution of a symmetric unit, he uses but the two vertical push buttons plus filter controls; on an asymmetric unit he first sets the luminaire to the desired lateral orientation by the lateral push buttons and then proceeds as before. To read the lateral distribution in a cone, he sets the cell vertically at the angle of the cone and then rotates the unit from angle to angle for lateral readings by the lateral push buttons.

Since the completion of this project, we have found few technical errors in the design. There are, however, improvements to be made, and these, one by one, are being put in effect in the order of their importance.

In the way of additional equipment, we find that a recording device of some kind might be used to advantage on some design tests. Provisions for use of recorders have been incorporated into the controls.

We find that for most of our work this new photometric laboratory does a splendid job. The equipment is easy to use and the test work can be speedily handled. In particular the separation of control room from dark room promotes a more cheerful atmosphere for the photometrist and design engineers.

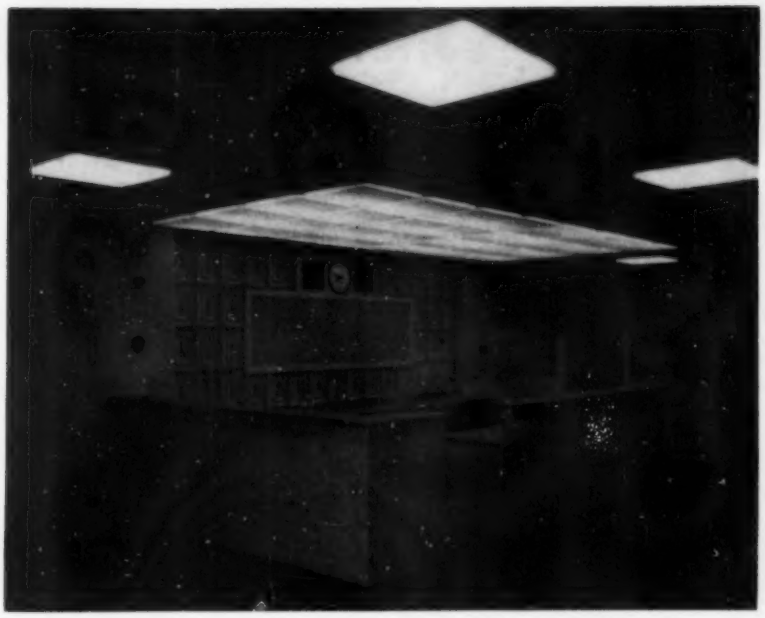
We are submitting this description in hope that it may contain some helpful suggestions for the design of an up-to-date photometric laboratory.

We gratefully acknowledge the accomplishments which J. R. Green, our test engineer, has contributed to the design and construction of all phases of the new laboratory.

Luminous panels, 8 x 12 feet in size, are formed from the individual units in lounge area of hospital.

Individual Units Combine For Versatile Lighting Systems

Here units are used singly, where high level of illumination is unnecessary.



A luminous ceiling of 32 pans provides 48 footcandles at the nurses' station, where good visibility is imperative.

ONE of the major advantages of the lighting system used in the Grace New Haven Community Hospital is its versatility. Individual units have been spaced as required in corridors and, where higher of levels of illumination are desirable, are combined into luminous panels or luminous ceiling.

The two-foot-square recessed luminaires use, as a diffusing medium, pans of ⅛-inch pale ivory-colored plastic, hung in an extruded aluminum bezel, piano-hinged with captive thumb screws for locking. Reflectors are of baked white enamel, and in individual units four 20-watt lamps are used.

Some of the areas requiring high levels of illumination are the twenty nurses' stations, located at the junction of two corridors, where visibility of station nurse by floor nurses and visual control of corridors by station nurse are imperative. The ceiling area directly over the station is of typical luminous ceiling construction, using 32 pans similar to the individual units. Forty-watt fluorescent strip is mounted on 14-inch centers in a white painted plenum; a level of 48 footcandles was measured after two months' operation. Pans are removed for maintenance by the tip-out method and cross supports are removed from the slotted holders or joiners for relamping.

Ceiling is white (75% RF); walls are gray and terra cotta (40% RF), and counters are tan (30% RF).

This installation was the entry of the late Cecil K. White, Grand Light & Supply Co., New Haven, Conn., in Connecticut Section's 1953 contest for My Most Interesting Lighting Job.

Single and double installations alternate in the corridor to the accounting office.

Decorative Lighting For a Young Man's Bedroom

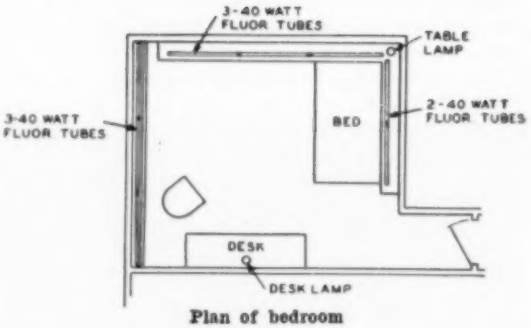
A STRIKING display of highlight and shadow produces a background of illumination appropriate to the design and decoration of this young man's bedroom — appropriate also to the interests of the occupant by placing accent on his collection of framed photographs mounted on the wall.

General illumination is furnished by a wall-to-wall valance over the window, in which three 48-inch fluorescent lamps are mounted in channel at a 45-degree angle to direct the light upward and out over the ceiling of the room.

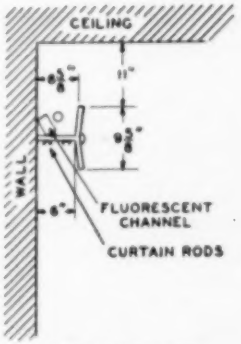
Concealed behind a strip of etched glass in the top of the decorative cabinets which line two sides of the room, continuous strips of fluorescent lamps accent the photographs on the wall above and also light the shelf sections in the cabinet below. Portable lamps are used on the desk and beside the bed.

The room is approximately 12 x 14 feet with an 8-foot 11-inch ceiling. Walls are painted a dark rose red and the ceiling a very light chartreuse. Draperies and bedspread are of a white and light green weave and the carpet is a light gray. Furniture is of grayed oak.

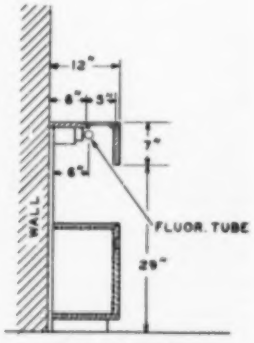
Photo and data supplied by Roger Dussault, Interior Decorator, Quebec, Que.



Plan of bedroom



Detail of valance



Detail of cabinets

Suppression of Radio Interference In Fluorescent Lighting Installations

By GLENN WALTERS

Radio interference caused by fluorescent lamps is not a new problem. And considering the number of lamps now in use, it is surprisingly a relatively minor problem. However, occasionally interference in an installation reaches the annoyance level and steps must be taken to correct the situation. The purpose of this article is to suggest means for suppressing interference.

RADIO interference is the result of noise mixing with a broadcast signal and producing at the receiver output the familiar crackling "static." The term noise, as used in this article, refers to the stray electric and magnetic fields generated within the fluorescent lamp.

The noise field radiates outward from the lamp and also induces waves which travel along the wiring. It is well known that, in general, noise can be prevented from reaching the receiver by properly shielding the lighting system, by installing filters to prevent propagation back along the wiring, and by installing conductors to shunt the noise currents to ground. Reception can also be improved by shielding the receiver and its antenna.

From laboratory tests and experience on actual lighting installations several specific methods of suppression have been evolved. To apply these effectively several factors must be considered; the type of installation (factory, home, etc.), the wiring layout, types of lamps, ballasts, and starters, the characteristics of receiver and antenna, the strength of the broadcast signal and the degree of suppression required.

The discussion of these methods and factors, which follows, should provide a guide for planning new installations and for improving reception in existing installations.

The Noise Source

The principal noise source in the lighting system is, of course, the fluorescent lamp. The noise is generated by cathode bombardment and by collision of charged particles in the arc stream. In this respect the lamp acts much like other gaseous discharge devices.

Most of the noise appears to be generated at the instant when the discharge changes from the glow type to an arc: that is, when the cathode hot-spot forms on 60-cycle per second operation this occurs 120 times per second.

Because of the activity at the cathode the noise output of a fluorescent lamp is extremely variable. The greatest output usually occurs immediately after the lamps are turned on, but after a short burning interval the lamp stabilizes and the noise subsides to a lower level.

Different lamps of the same type may show as much as 1000 to 1 variation in noise output. Moreover, the output of a given lamp may vary a similar amount during its life. Some lamps tend to produce less noise near the end of life, and others more. In some cases one cathode may fail, causing the lamp to rectify. Such lamps may be extremely noisy.

This variability makes it difficult to compare different types of lamps and to rank them with respect to noise output. It appears, however, that rapid-start lamps are "quieter" than other types because continuous heating of the cathodes makes lamp restarting each half cycle easier. Low-wattage lamps and operation at low currents also tend to produce less noise.

Variability in noise output also complicates the suppression problem. For example, one may attempt to suppress the interference and obtain what appears to be sufficient suppression only to find several hours later than the level has increased, so additional suppression is required. Again, measurements of noise levels, which might be expected to give quantitative indication of how much suppression will be needed, are difficult to reproduce.

Noise may also be produced by faults in the lighting system. A common fault is poor contact

AUTHOR: Ballast Engineer, General Electric Co., Danville, Ill.

between the lamp pins and the sockets. This results in arcing which may generate a tremendous amount of noise. The condition can usually be corrected by turning or jiggling the lamps until the pins are properly seated. It may be necessary in some cases to readjust the spacing between sockets.

Arcs may also occur between poorly insulated lead junctions and the fixture; between the fixture and a filter case, where the case is supposed to be grounded to the fixture but actually is not. On rare occasions internal arcing and corona in the ballast may occur; sometimes this fault is indicated by a slow build-up of the noise level immediately after the circuit is energized.

It is sometimes helpful to think of the lamp as a radio-frequency generator having a certain internal generated emf and an internal impedance which is resistive in character. A 40-watt preheat lamp may have, for example, an internal voltage of 530,000 microvolts and an internal resistance of 1450 ohms. This representation has limitations, of course, because of variability in noise output and radiation effects.

Characteristics of the Noise

The noise voltages generated in the fluorescent lamp are of a random nature, the result of the "statistical" process within the bulb. Consequently, the disturbance is spread out more or less over the entire frequency spectrum, unlike a broadcast signal which is confined to a narrow band.

The largest noise amplitudes are observed in the broadcast range, 550 to 1600 kilocycles per second. Amplitudes at higher frequencies, particularly in the frequency modulation and television bands, are practically negligible.

Hence, suppression needs to be considered only for the broadcast range. In discussing suppression methods we shall assume that only the broadcast range is being considered.

Propagation and Reception

Noise may propagate from the source to the receiver in four ways: (1) by direct radiation from the source, (2) by conduction back through the ballast and the supply lines, (3) by radiation from the supply lines, and (4) by induction of currents on nearby wiring from which there may be feedback and radiation.

The radiated field has two properties that can be used to advantage. First, near the source the energy associated with the electric component is considerably greater than the energy associated with the magnetic component. Far from the source the energies are equal. Hence, a shield around the receiver and its antenna which blocks the electric component but not the magnetic should suppress the noise field but not the broadcast signal. Consequently, if the receiver has a properly designed antenna, noise from the lighting system should not cause interference. Also, it is possible to restrict the noise field to the vicinity of the lighting system by means of fairly simple shielding.

Second, the strength of the radiated field diminishes rapidly with distance. Hence, it is possible to eliminate that mode of interference simply by locating the receiver and antenna at a sufficient distance from the lighting system. Tests indicate that the distance should be at least eight to ten feet. Since a certain amount of noise may be induced on the chassis of the receiver, particularly when the chassis is not grounded, the chassis should also be remotely located in cases where a separate antenna is used.

Line feedback exists by virtue of radio-frequency currents flowing over the supply lines and building up voltages between the lines and ground. If the feedback reaches the receiver, currents will be induced in the antenna through the distributed capacitance existing between antenna and ground and between chassis and ground. Line-to-line voltages also exist but these are filtered out by the power transformer in the receiver. If the receiver is of the ac-dc type, line feedback is likely to produce more interference because the chassis is not grounded and there is no power transformer.

Line feedback will be attenuated to some extent because of radiation from the supply lines and the shunting effect of line-to-ground capacitance. Consequently, interference due to feedback will be less the longer the line between lamps and receiver.

Interference through induction of currents on wiring near the lighting system is a mode which is often overlooked. This may be especially bothersome when there is a considerable amount of line radiation or where the branch circuits are in close proximity.

Reception may be adversely affected by the construction of the building. Steel frameworks and metal lath attenuate the incoming signal. This effect is often observed on car radios when the automobile is driven through an overhead steel truss bridge. In such cases a given noise level will, of course, cause more interference.

In some installations the supply lines may act as a partial antenna for the receiver. This effect has an important bearing on the suppression of line feedback, as will be discussed subsequently.

With this brief look at the causes of interference we can proceed to the discussion of suppression methods.

Suppression at the Source

The most direct way to improve reception is to suppress the noise at its source. The noise may be suppressed by (1) shielding the lamps and (2) establishing low radio-frequency impedance paths across the lamps and to ground. This assumes that other possible sources in the lighting system have been searched for and eliminated and that the fluorescent lamps are definitely established to be the source.

Direct radiation from a lamp can be suppressed by enclosing the lamp as completely as possible with metal shields. The shields should be good electrical conductors and be grounded. (Grounding is discussed in a later section of this article.)

In most installations the lamps are already partly enclosed by the metal body of the fixture. The shielding may be improved by covering the open face of the fixture with copper screen. The screen should be in good electrical contact with the fixture body and the fixture grounded.

Such complete shielding would probably be needed only in situations where extremly low noise levels are required, for example in radio shops, or where the receiver must be located close to the lamps.

In some installations fluorescent lamps are located in valances in which there are no metal fixtures and the ballasts are remotely located. Interference from such installations may be severe. It may be advisable to line the inside of the valances with copper or aluminum foil.

An effective way of short-circuiting the noise generator is to connect a small capacitor from each end of the lamp to the fixture. All of the capacitors in a given fixture should be grounded at the same point on the fixture.

However, in practice it is sufficient to shunt a single capacitor across each lamp. The value of the capacitance should be in the range 0.005 to 0.010 microfarad. A capacitance of that size is almost a short-circuit at radio-frequencies but does not affect lamp operation otherwise — in fact, starting may be aided in some cases.

The capacitance value should not be much greater than 0.010 microfarad, because larger capacitors may have an appreciable inductive effect at radio frequencies and may give less suppression.

Paper-dielectric capacitors of the type sold in radio parts stores may be used for this purpose. The capacitors must be rated for an a-c voltage sufficient to withstand the starting and operating voltages of the particular lamp. It is advisable to secure recommendations from the lamp or ballast manufacturer as to the required rating.

Starters for preheat-starting lamps are usually provided with suppression capacitors. That type of starter should be used where interference may be a problem. Some ballasts also contain capacitors which are in shunt with one or more of the lamps; these capacitors will be less effective when the ballast is located remotely from the lamps and additional capacitance may be needed.

In connecting the capacitor across the lamp the leads should be as short as possible. Otherwise, the loop consisting of lamp, capacitor, and leads may act as an antenna and increase the radiated noise slightly. It has been found that a capacitor across the lamp, properly installed, will reduce radiation from the lamp.

Capacitors across the lamps will in most cases reduce the interference so that reception on local stations is practically noise free. For reception of weak, distant stations additional suppression may be needed.

Suppression of Line Feedback and Radiation

Neither line feedback nor line radiation will exist if the radio-frequency noise currents can be shunted to ground at the ballast. It would be highly desirable if the ballast could be built to perform that filtering action.

Now transformers used in certain other applications are constructed with the primary and secondary windings electrically isolated and with an electrostatic shield between windings. When the shield is grounded, the capacitance between conductors of the secondary and the shield provides a low radio-frequency impedance path to ground. Thus, only small amounts of noise are induced back into the primary.

Fluorescent lamp ballasts are not built in that way because of cost considerations, so the ballast itself provides little or no attenuation. Moreover, ballasts for the small wattage lamps are often just reactors with no portions shunted across the line; the attenuation may be less than that obtained with ballasts containing autotransformers.

Multi-lamp ballasts vary considerably in winding arrangement; the two basic types are of course, the lead-lag and series. Neither type is inherently better than the other so far as interference is concerned. However, certain specific designs may happen to give better suppression because of either built-in capacitors or capacitors elsewhere in the lamp circuit. As mentioned previously, some series ballasts contain a capacitor which shunts one lamp; the main purpose of this capacitor is to facilitate starting, but it also reduces interference. Again, starters used in single-lamp and lead-lag switch-

start circuits usually are provided with suppression capacitors.

Industry specifications on radio interference suppression presently require that ballasts for lamps other than the preheat-starting type contain a suppression capacitor connected across the ballast input. Under some conditions that arrangement may not provide adequate suppression because the line-to-ground noise voltages are not affected. Hence, it may be necessary to install filters at the ballast input.

A simple type of filter is the capacitor type, consisting of three capacitors connected in delta between lines and between lines and ground. Filters of this type are readily available on the market. Tests in actual installations indicate that to secure adequate suppression the line-to-ground capacitors may have to be as large as 0.1 microfarad. Since a capacitor of that size may introduce a shock hazard, particularly on portable equipment, the capacitance must be limited to smaller values.

To keep the capacitance within safe limits and still secure sufficient attenuation an inductive-capacitive filter should be used. Whichever type of filter is used, one unit should be installed for each eight-foot length of fixture. All fixtures in the installation should be filtered, not just the ones which happen to be noisy at a particular time.

Filtering at the ballast has definite limitations because the noise may to some extent by-pass the filter. Filters will be much more effective if the supply lines are in conduits, or otherwise shielded. This will suppress radiation from the lines and shunt to ground the noise that by-passes the filter.

A more difficult situation is an installation in which the ballasts are located remote from the lamps and fixtures. Filters at the ballast will be even less effective because of radiation from the lamp leads. In this case both capacitors across the lamps and an inductive-capacitive filter at the ballast input may be necessary.

If the supply lines are shielded and the ballasts located at the fixtures, a filter at the receptacle or outlet where the radio is plugged in should be sufficient. This arrangement considerably reduces the number of filters needed. A delta-capacitor filter is adequate for this purpose. Of the various filters available on the market one style, which is especially convenient, has a cylindrical shape with a plug on one end, a receptacle on the other end, and a grounding lug along the side. Safety precautions should be observed in grounding the filter.

When the supply lines are unshielded, a line filter, either at the ballast or at the radio, will reduce the antenna effect of the lines. This effect was mentioned in the preceding section. Thus, the filter may shunt out noise but at the same time reduce the signal strength. So the net gain may be small. If this effect exists, a better antenna should be installed.

Line filters should not be considered as a cure-all solution for interference. Because of the wide variety of conditions encountered, it is difficult to predict how effective a filter will be or to place a numerical value on the amount of attenuation a particular filter might produce. Moreover, one should not expect that suppression can be secured by ballast design alone.

Shielding the lighting circuit supply lines will prevent induction in other branch circuits. If possible, the lighting circuits should be physically separated from the other circuits.

Improvement of the Receiver and Antenna

An important factor in the suppression problem is the receiver itself. A radio receiver, when tuned to a particular center frequency, detects and amplifies a relatively narrow frequency band. Thus the receiver absorbs only the noise energy within that band. Interference can therefore be reduced by narrowing the band-width. In well-designed receivers the band-width is as narrow and sharp, or highly selective, as is consistent with good fidelity. Sets should be lined up occasionally.

Interference due to radiation can be reduced, as mentioned previously, by locating the receiver and antenna at a distance of at least eight to ten feet from the lamps. In modern receivers the antenna—usually a loop—is built into the set.

In case the receiver must remain in close proximity to the lamps or where the radiated noise is very strong one should consider replacing the antenna.

Probably the most effective antenna is a doublet, strung outside the building. The lead-in wires to the set should, of course, be shielded. If the signal is weak because of shielding by the building, an outdoor antenna may be a necessity.

As an alternative one can use a "ferromagnetic" antenna. This type reacts to the magnetic component of the field but is shielded against the electric, thus employing the property mentioned under "Propagation and Reception." One version, available at radio shops and costing under a dollar, is simply a coil wound on a powdered iron core. The core is shaped so that the coil is fairly well shielded. This antenna proved reasonably effective in an installation in which the supply lines had a pronounced "antenna effect" on the receiver; it gave better reception than the loop built into the set,

and provided along with line filters an economical solution for that particular problem.

Reception is also improved if the receiver chassis is grounded. It should be noted that the chassis of a set not having an isolation transformer (as is typical of ac-dc table model radios) may be at line potential and cannot be grounded.

Grounding and Safety Precautions

The purpose of a ground is to provide a low impedance path for the radio-frequency noise currents. Accordingly, the ground conductor should be as short and heavy as possible. Use No. 14 gauge conductor or, preferably, a copper strap having a large ratio of width to thickness. One can, of course, make use of the wiring conduit and water pipes in the building.

Under certain conditions a ground conductor may act as a noise radiator and increase the interference. Hence, the effect on reception should be checked before the conductor is permanently installed.

In steel-framed buildings the fluorescent fixtures are often grounded by virtue of the suspension hardware. Filters installed at the fixture can therefore be grounded easily by establishing good electrical contact between the fixture and the filter case or grounding lug.

Failure to ground the neutral of branch circuits, as required in the National Electrical Code, may increase interference. If the supply lines are not properly grounded, filters will be less effective.

Caution must be exercised in installing filters lest a shock hazard be introduced. In a delta-capacitor filter, for example, the ground junction before connection may be at full line potential with respect to ground potential. When contact is established, perhaps accidentally through a human body, the impedance of the filter must be sufficient to limit the current to a safe value. A safe value is 0.3 milliamperes according to some authorities. Using that value, the capacitance at 60 cycles per second must be less than 0.006 microfarad. (Capacitance connected across the line may be greater.) It is especially important to consider the possibility of shock hazards on portable equipment.

Planning a New Installation

In planning a new fluorescent lighting installation some consideration should be given to radio reception. This is especially true where the installation is to be made in a radio store, radio laboratory, in a school, or in a home. (Some schools use radio programs in their classes; stations carrying programs of interest may be located in other cities so the received signal is quite weak.) It can probably be assumed that in such locations very good suppression will be required.

The most effective way of suppressing interference is to shield the lighting system. That is, place the wiring in conduit and mount the lamps in grounded metal fixtures. In addition inductive-capacitive filters should be installed; or, alternatively, install delta-capacitor filters at the receptacles. Where extremely low interference is required, the open faces of the fixtures should be covered with copper mesh.

Home installations present a more difficult problem, because initial investment is a primary consideration. A mitigating factor is that most people are satisfied if their local stations are received free from interference. This can usually be secured by specifying that suppression capacitors shunting each lamp be installed. If a switch-start system is to be used, specify starters having suppression capacitors. Where better reception is desired, an outdoor antenna with shielded lead-in wire is recommended.

Application of Suppression Methods

So far we have discussed suppression methods mainly in relation to how the noise is generated, propagated, and received. The problem to be considered now is the practical application of these methods. In other words when one is confronted with an interference problem in a particular installation, it should not be necessary to make extensive measurements of lamp radiation, line feedback, etc., in order to decide what suppression measures should be taken. From experience we have found that certain of the methods will effective suppress interference in most situations. These methods have been organized into a suppression procedure. Thus, the first method is tried; if the suppression is inadequate, the second is tried, and so on. In setting up this procedure we have considered cost, convenience, and probable effectiveness. The steps are:

(1) Make certain that the interference is not caused by a device other than the fluorescent lighting system. Of course, if the interference is present only when the lamps are on, the source is the lighting system. One should check for arcing at the sockets and replace lamps which are rectifying or are otherwise defective.

(2) Locate the radio at least eight to ten feet from the nearest lamp. (The best location — to minimize interference due to lamp and line radiation — can be determined by use of a battery-operated portable radio.)

(3) Install a line filter at the receptacle where

the radio is plugged in. This is especially effective in installations where the supply lines are shielded (in conduit). The simplest filter is the delta-capacitor type. Observe safety precautions in selecting the size of the capacitors and in making the ground connection. If the supply lines are not shielded, the lines may act partially as an antenna for the radio, in which case installing the filter may reduce the received signal strength. Some improvement may be made at this point with an antenna system which offsets the loss caused by the filter (see below).

(4) Install a line filter at the ballast. This will probably be required when the supply lines are not shielded. The best filter for this purpose appears to be the inductive- capacitive type. Make certain the filter is properly grounded. If this method is effective, a filter at the radio outlet will be superfluous.

(5) Install capacitors in shunt with each lamp. If the circuit is switch-start, the starters may be the type without suppression capacitors, in which case they should be replaced. On other systems the ballasts may already contain suppression capacitors across the lamps, but if the ballasts are located remote from the lamps the capacitors in the ballasts will not be as effective, so additional capacitors should be installed in close proximity to the lamps. These capacitors must be rated to withstand the starting and operating voltages of the particular lamps. This method may have to be combined with Method 3 or 4 if the interference is severe.

(6) Install a better antenna. Some improvement over a small loop built into the receiver can be secured at small cost with a "ferromagnetic" antenna of the type described previously. An outdoor antenna will provide the best reception possible for a given noise level, and may be a necessity where the building construction is such that the building acts as a shield to the broadcast signal.

(7) In some cases it may be necessary to shield the lamps, or cover the open face of the fixture, with copper screen. This may be advisable where the receiver must remain within short range of the lamps and if the preceding methods do not provide adequate suppression.

(8) For extremely low interference both the lamps and the supply lines must be shielded.

To determine how much suppression is obtained at each step the most practical procedure is simply to tune the receiver to a station of moderate strength and listen to the result. The sensitivity of most receivers and the spectral distribution of the noise energy are such that the interference is a maximum at about 1000 kilocycles.

Receptive result may be obtained if the receiver is not tuned to a station. Most AM receivers are provided with an automatic volume control circuit (AVC) which compensates for changes in signal strength. The action of the AVC may cause the noise level to appear high when the dial is not set on a station.

Cafeteria Lighting for A Cheerful Atmosphere

Cove lighting, troffers and downlights combine to provide 30 to 50 ft-c in the employees' cafeteria at Richfield Oil Co., Los Angeles. Thirty-six two-lamp louvered troffers, containing standard cool white single-pin instant start lamps, are arranged in four continuous rows. A total of 24 recessed baffled downlights, using 150-watt R40 reflector lamps, are located in the drop cove ceiling. Cove lighting is from a continuous row of single lamp channel. Illumination ranges from 30 ft-c on the tables to 50 ft-c under the downlights. Walls are gray, tables cream and chairs blue. The two pillars are deep blue, and floor is of black and cream tile. Photo courtesy Department of Water and Power, City of Los Angeles.

INSTALLATION AT MACEDONIA, OHIO

Lighting a Remodeled Kitchen

LIGHTING OBJECTIVE: (1) To provide recommended levels of lighting at all work areas in this remodeled kitchen; (2) to satisfy the owner's desire for a "day-lighted" kitchen without the use of typical ceiling-attached luminaires.

GENERAL INFORMATION: This 12 x 13 foot kitchen has a 9-foot ceiling. The U-shaped arrangement of appliances and work areas somewhat resembles the old-fashioned farm kitchen in that there is a generous-sized work table in the center of the room. The 13½ cubic foot refrigerator is set in an alcove on one of the 13-foot walls, while the dinette is in a 6½ by 11 foot alcove in the opposite wall. (See Data Sheet No. 22-36 for lighting of dinette.)

The counter tops and walls below the cabinet line are finished in yellow gloss tile (70% reflectance). Custom-made wooden cabinets are of birch, finished in a warm cork tan — about 35% reflectance. Ruffles of figured chintz are used around the two small kitchen windows to allow for maximum daylighting. The floor is of random red-clay-colored tile — about 20% reflectance. Much of the carpentry and electrical work was done by the owner.

INSTALLATION: This country house was 85 years old when remodeling was started. Like many a kitchen of that era it had no wall-hung cabinets. There was better than a foot of space just below the ceiling around the perimeter of the room not suitable as storage area. Instead of building the usual plastered soffit, the idea was conceived of making this space the source of general lighting in the room. A hollow 11 by 12 inch box, open on the vertical surface facing the room, was built along three walls of the kitchen. In this white cavity a single row of six 72T8 standard cool white slimline lamps mounted end to end on 1¼ by ⅞ inch cross-section wiring channel (Wiremold #2188W72) was placed as shown in Fig. 3. A strip of white corrugated Marlux plastic 11 inches wide was inserted in the framework of the open vertical surface facing the room to form a luminous panel just below the ceiling line. The 300 ma ballasts were located in attic space above the kitchen.

(over)

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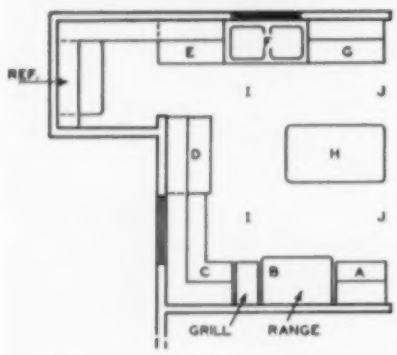

Figure 2. (above) Plan view.

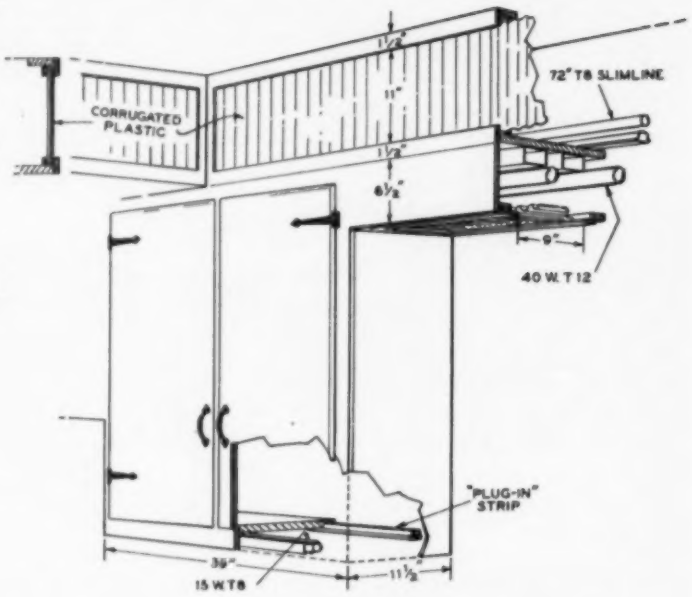

Figure 3. (right) Installation details.

In a 4-foot wide space over the sink an additional 6½ inch deep cavity was built on the bottom of the perimeter cavity to house (as shown in Fig. 3) two 40-watt fluorescent lamps. A 9 by 46 inch strip of the corrugated plastic rests on the bottom framing of this cavity. A similar arrangement (using two 42-inch T-6 slimline lamps) lights the refrigerator niche.

This same idea was suggested for the area above the range (opposite sink — not shown in photograph) but could not be done because of the position of the exhaust fan pipes. A 25-watt or 40-watt fluorescent bracket is needed above the range.

Under-cabinet lighting is provided by T-8 15-watt standard cool white fluorescent lamps (on Wiremold #21A10 channel) placed at the front edge of the five cabinets above positions A, C, D, E, and G in Fig. 2. Fig. 3 shows this construction as well as the National Lighting Products Plug-in Strip which is recessed in the bottom of all cabinets.

A recessed louvered luminaire with a PAR-38 150-watt flood lamp provides 50 to 70 footcandles on the work table which is also a much-used chopping and carving surface. This hard wood chopping-board of course has no stain or varnish and is therefore a matte surface having no properties of specular reflection of the light source.

General lighting from the perimeter system varies between 13 and 17 footcandles on a horizontal plane 30 inches about the floor. The addition of all the local lighting increases these readings (not including any measurement on center work table) to between 15 and 20 footcandles. Illumination readings at other points are as indicated below:

Location (See Fig. 2)	Local Lighting Only	Perimeter Lighting Only	All Lighting
A	38 ft-c	10 ft-c	48 ft-c
B	5 "	12 "	17 "
C	40 "	12 "	52 "
D	38 "	11 "	49 "
E	43 "	10 "	53 "
F	44 "	10 "	54 "
G	40 "	10 "	50 "
H	70 "	17 "	87 "
I		13 "	17 "
J		13 "	17 "

Brightness of the corrugated plastic is perfectly even, visually, and measures 350 footlamberts. The highest brightness of ceiling directly above the luminous panels is 80 footlamberts and goes gradually down to 10 footlamberts in the center of the ceiling. Wall cabinets average 9 footlamberts with perimeter lighting on.

Lighting data submitted by Robert L. Oetting, General Electric Company, Nela Park, Cleveland 12, Ohio as an illustration of good lighting practice and to aid in the design of similar installations.

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Series XIX 4-54

INSTALLATION AT MACEDONIA, OHIO.

A Luminous-Ceiling Dinette

LIGHTING OBJECTIVE: To provide lighting in a dining alcove which is also used as a study area for two children and for games and hobby work by both children and adults.

GENERAL INFORMATION: This dinette is a 6 foot 6 inch by 10 foot 8 inch alcove of a large kitchen. (See Data Sheet No. 22-35 for solution of kitchen lighting problem.) It originally had a ceiling sloping from 9 feet to 7 feet 8 inches. Walls are painted light yellow (75% reflectance). A large cork tackboard covers most of one end wall and short draw draperies of figured chintz in shades of brown and yellow cover most of the other two walls. The dinette table top is of satin-finish yellow plastic laminate and chairs are upholstered in yellow leather.

INSTALLATION: A false ceiling to level it off at its lowest point, 7 feet 8 inches above floor, was installed in the dinette area. In a 30 inch by 96 inch by 8 inch deep cavity directly above the table four 96T8 standard cool white slimline lamps were installed as shown in the sketch. Two 14-inch wide strips of corrugated vinyl plastic (Marlux) were laid on the bottom framework of this cavity which had been painted flat white. The four lamps were put on two circuits — the two inside lamps on one circuit and the two outside lamps on the other. The ballasts are located in the attic space above the kitchen.

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A Luminous-Ceiling Dinette (continued)

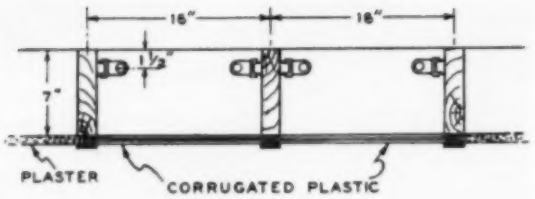

Figure 2. Cross-section of luminous ceiling cavity.

The high quantity and the uniformity of illumination on the table surface makes this an excellent place for study or hobbies and games. When used for study, the recommended practice of elevating reference books to a 45-degree angle completely eliminates the specular image of the luminous element. Its brightness is 350 to 750 footlamberts when looking directly up at it. Reflections from note and bond paper widely used by students are quite low in value and therefore acceptable when used in the flat horizontal position.

Lighting Measurements	One Circuit		Two Circuit		
	Ft-c	Ft-L	Ft-c	Ft-L	
Average on table surface	30	19	60	38	
From seated position at end of table — looking at far end of plastic				350	
From seated position looking straight up				750	brightest area
Center of tackboard			40	15	

Lighting data submitted by Robert L. Oetting, General Electric Company, Nela Park, Cleveland 12, Ohio as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Instrument for the Evaluation of Night Visibility on Highways

Discussion of paper by A. E. SIMMONS and D. M. FINCH

(Published October 1953 issue of ILLUMINATING ENGINEERING)

C. L. COTTRELL*: This paper is a good report of work on an important problem, well-described and discussed by the authors. The authors state that visibility may best be defined by its relation to visual thresholds of one type or another. This may be true but there seems to be little direct scientific confirmation of this statement. Could not optimum road seeing-conditions be so correlated with traffic accidents per car-mile as to further justify such a statement, being careful to consider only those accidents in which a failure of visibility was the primary factor? Perhaps the Street Lighting Committee is considering such a study.

In regard to the technique of making the threshold measurements, I have a few questions and comments.

The need for as complicated an optical system as was used is not clear, especially since a wider angle of view, if desired, might be had by viewing the scene directly without optics. The small mirror could still reflect the detail desired after having its contrast reduced by the gradient filters and superimposed brightness area.

To block out glare from the street lighting sources, could not screens be interposed of just large enough size and thus prevent the reduction in size of the field of view? However, except for peripheral glare sources, the size of the field of view beyond about seven degrees does not appear to be very important in some threshold measuremnts made by the writer.

To produce a more constant $t_b + t_v$ sum, perhaps polaroid filters might be used with a suitable cam mechanism and a circularly polarizing element to correct for the partially polarized light from the road surface.

Corrected meter readings are included in the data. A note on how these corrected values were obtained would be appreciated. At 90° in Fig. 3, it appears that the total background brightness is reduced to a rather small fraction of that of the surround.

Would the authors care to comment on the effect of fog conditions on their technique?

ALEX W. CHRISTIE**: Simmons and Finch[1] are to be congratulated on pursuing the development of a visibility meter for the appraisal of highway lighting. Their meter has interesting possibilities. But they have not made clear what it measures and there appears to be an error in the formulation of the theory of its operation, or something has been unintentionally omitted. They appear to be prepared to accept a somewhat arbitrary scale which cannot be interpreted without a great deal more work although the meter seems designed to measure a quantity which may be simply defined and whose relevance to the problem of the visibility of an object against a background is undoubted.

The apparent omission occurs in working out the theory of the instrument where account should be taken of the direct transmission and reflection factors of the "half mirror." Let those be t_m and r_m respectively. Let B'_b and B'_o be the background and object luminances as seen through the instrument. Then using the other symbols defined by the authors.

$$B'_b = r_m t_b B_b + t_m t_v V \quad (1)$$

$$B'_o = r_m t_b B_o + t_m t_v V \quad (2)$$

In the third stage of the operation of the instrument the adjustment of the veiling luminance makes

$$t_m V = B_b \quad (3)$$

This makes

$$B'_b = B_b \quad (4)$$

provided that the double optical wedge is so constructed that

$$r_m t_b + t_v = 1 \quad (5)$$

In the fourth and final stage of the operation, the rotation of wedge W reduces B'_o until the object is just visible through the instrument. Then the luminance difference $B'_b - B'_o$ is equal to the threshold value T' at the background luminance $B'_b = B_b$ for that type of object under the conditions prevailing in the street.

$$T' = B'_b - B'_o = B_b - B'_o = r_m t_b (B_b - B_o) \quad (6)$$

Let us denote by R the ratio of the actual luminance difference $B_b - B_o$ to the threshold value T'. Then

$$R = \frac{B_b - B_o}{T'} = \frac{1}{r_m t_b}. \quad (7)$$

Thus it is the ratio R which is obtained from the instrument and not a measure of the contrast threshold (T'/B_b) as is stated by the authors.

The threshold difference T' is greater when glare sources are present in the surrounding field. It is necessary that the instrument should take into account the effect of the glare on the value of T' applicable to the correct background luminance B_b. This can be done only if $B'_b = B_b$, i.e., only if conditions 3 and 5 are satisfied. These conditions are different from those specified by the authors. But condition 3 involves no change in procedure, being merely a more accurate formula for the luminance match which is made in the third stage of the operation of the instrument. If r_m is made large (and consequently t_m small), as seems advisable, condition 5 differs little from that given by the authors.

In the above discussion it has been assumed that transmission losses in the lens systems are small. Flare light in the instrument due to glare sources might have a serious effect on the validity of the readings. It is, of course, essential that only "glare effect" which is measured should be that which occurs in the eye itself and not that due to flare images in the instrument. The amount of this flare light would be a point worth investigating.

Dunbar[2] discussed the significance of the ratio R in a paper on the fundamental principles of visibility meters. If the luminance of the background (B_b) is kept constant whilst the object luminance (B_o) is varied, the probability of detection (P) may be determined at each setting and plotted as a function of R. For each value of B_b a sigmoid curve is obtained and the curves for different values of B_b all pass through a fixed point which depends on the definition adopted for the threshold (say $P = 0.5$ at $R = 1$). Such curves could be used to convert values of R into probabilities of detection P.

Dunbar[2] quotes results from an earlier experiment[3] in which the voltage to the filament lamps in a street lighting installation was varied and the luminance difference $(B_b - B_o)$ for a constant level of visibility assessed at each setting. This difference was found to be an approximately

*Cornell University, Ithaca, N. Y.
**Road Research Laboratory, Department of Scientific and Industrial Research, Harmondsworth, England.

constant multiple of the *laboratory* threshold difference T, i.e.

$$\frac{B_b - B_a}{T} = \text{constant}.$$

If this result is general for different levels of visibility we might expect T'/T to be constant and therefore $R = (B_b - B_a)/T'$ to be constant also. Thus it may be possible to choose a standard curve relating the R with the probability of detection. Before this could be done it would be necessary to show that the probability curve is sufficiently constant not only at different levels of background luminance but also in different types of installations and with different degrees of glare. Even if the probability curve turns out to be not sufficiently constant for this purpose, the ratio R itself is likely to prove more meaningful and useful than an arbitrary scale. It could at least be estimated by other workers using different methods.

It should perhaps be pointed out that the values of R obtained refer to particular objects in particular situations. Street lighting installations could only be appraised in terms of standard objects set up in them.

A scale attached to the control for setting the veiling luminance V could be used to give the background luminance B_b. This would add to the usefulness of the instrument.

In conclusion I should like to suggest that it would be well worthwhile developing the meter in order to obtain accurate values of the ratio R before proceeding to use it in lighted streets. In that way the results are likely to be more intelligible and convincing to the many investigators to whom they are likely to be of interest.

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1. Simmons, A. E., and Finch, D. M.: "An Instrument for the Evaluation of Night Visibility on Highways," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 10, p. 517 (October 1953).
2. Dunbar, C.: "Fundamental Principles of Meters Used to Measure Visibility," *Trans. I.E.S.*, London, Vol. V, No. 3, p. 33 (March 1940).
3. Dunbar, C.: "Necessary Values of Brightness Contrast in Artificially Lighted Streets," *Trans. I.E.S.*, London, Vol. III, No. 12, p. 187 (December 1938).

D. E. SPENCER*: There is one question that I should like to ask Professor Finch, in view of the fact that he is chairman of the Nomenclature Committee. He has been talking about the motorist's field of view and is interested in visibility under all types of weather conditions including rain and fog. Yet he speaks in terms of brightness. I would like to remind him that "brightness" as defined by the Nomenclature Committee does not apply to the description of the motorist's field of view under such weather conditions. A specification of the "brightness" of the pavement may have some meaning for the ant crawling on the road, but has nothing to do with what the motorist sees!

If the Chairman of the Nomenclature Committee is departing, in his research, from the artificial world of perfectly diffusing surfaces and perfectly clear media, in which "brightness" has some significance, is it not time for his Committee to scrap the present inadequate definitions? Is it not time for them to adopt a term** which is of significance in human vision, whether in fog or sunshine, in a perfectly diffusing world or in the real world?

D. A. TOENJES†: The authors have described an instrument and a technique that promises to be useful for measurement of night visibility under actual field conditions. An instrument which is portable and self-contained offers important advantages in field use. It will be of special interest to those who have used other techniques for taking measurements and making evaluations of street lighting installations, as well as automobile headlighting.

The instrument is compared, in the paper, with other measuring devices, including the Street Lighting Evaluator. In describing the Evaluator, the authors have said, "Brightness and Luckiesh-Moss visibility readings are made on the pavement strip and obstacle." We would define these measurements, made with the Street Lighting Evaluator, as simply *brightness* readings, obtained by brightness comparison against an adjustable brightness. The Luckiesh-Moss technique, using a variable filter in front of *both* the object and its surround to reduce both brightnesses to the point of threshold visibility, is not applied in the Street Lighting Evaluator.

In the Evaluator, the effect of veiling glare from light sources in the field of view is separately determined. It is then included in a final result, expressed as a numerical index, to indicate the over-all effectiveness of the street lighting installation. The Evaluator includes a glare shield, which can be changed to match the fields of view through various automobile windshields.

In describing the Street Lighting Evaluator, the authors have said, "The glare integrator is presumed to give a measure of veiling glare." The word "presumed" implies a criticism of the design work embodied in the glare integrator. This integrates the effect of light sources in the field of view from a driver's eye, in agreement with the relationships determined by Holladay and Luckiesh. We have no reason to believe that these relationships do not still apply.

Concerning the effect of veiling glare upon the Simmons-Finch instrument, the authors have stated, "The glare source used in the laboratory experiments caused a significant reduction in visibility meter reading. A great deal more work has to be done on this before the meter readings can be properly interpreted." Does the instrument include any glare shield limiting the field of view (of street lighting luminaires, for example) to conform to the boundaries of the field of view through an automobile windshield?

The authors say that the variable filter in their proposed instrument gave the most difficulty. In this feature has a shortcoming, it is serious for it means that *total* brightness of object or its surround is being changed, together with the intentional change in proportion of veiling brightness. Are we correct, then, in interpreting this to mean that the instrument is not yet ready to use?

One suggestion for solving this problem might be the use of two *separate* optical filter disks with a *mechanical* linkage such that $t_b + t_v$ were held constant. This might be easier than the preparation of a special graded filter disk or "optical wedge." The linkage could take the form of cams, or gears or pulleys of variable radii — not too difficult a kinematics problem.

In the field test described in the paper, we wonder if the *same* moving vehicle was used as a target in all tests. Were tail-lights included in this discernment? If traffic was present as stated, how were oncoming headlights taken into account so as to have the same effect in all tests?

The laboratory tests appear to have involved a scale model, in which the obstacle would span about one foot of projected roadway length, rather than 50 feet. Would not this difference be important on a pavement of uneven brightness?

*Associate Professor, University of Connecticut, Storrs, Conn.

**Such a term has been called "helios." See, for example, "Photometry," *Encyclopaedia Britannica*, Vol. 17, 1948, pp. 840-845.

†Application Engineering Dept., Lamp Division, General Electric Co., Nela Park, Cleveland, Ohio.

INSTALLATION AT JACCARD'S CLAYTON STORE, CLAYTON, MISSOURI.

Lighting a Silver and China Display

LIGHTING OBJECTIVE: To create different effects in various portions of the sales area in order to sell merchandise in an atmosphere similar to that in which it will be used.

GENERAL INFORMATION: Figure 2 is a plan view of the china display department and a typical portion of the jewelry department. Colors an l reflectances are as follows:

walls		
general area	green	22% RF
china section	gold	
woodwork	gray	60% RF
ceiling	cream	70% RF
floor	gray-white	50% RF

Incandescent filament lamps were chosen as the light source because of their flattering effect on feminine complexions and their harmony with the color of light source generally found in the home; also, they are the closest to the color of candlelight under which fine silver and china are frequently seen in residences.

INSTALLATION: General illumination is provided from recessed Pittsburgh Reflector Company type E-500 luminaires with plaster rings and hinged concentric louvers. Each luminaire has a mogul socket with capacity for a 300-watt incandescent filament lamp; however, the lighting level is changed as the displays are changed, by using smaller lamps in some areas to create theatrical display effects and direct sales attention to the merchandise to be emphasized. Spacing is 7 x 8 feet. The side wall displays are illuminated by Pittsburgh Reflector Company No. 56-2 show window reflectors with hinged eccentric louvers, mounted on two-foot centers around the side walls; these units employ 150- or 200-watt lamps depending on the seasonal interest.

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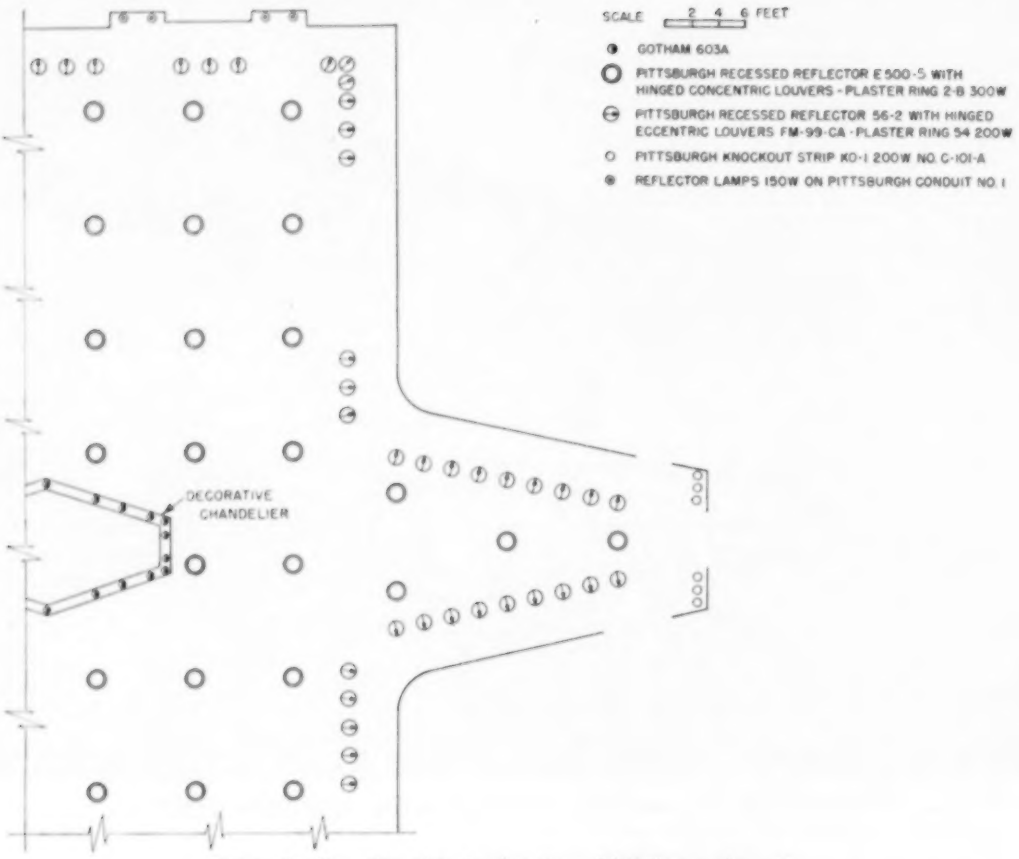

SCALE 2 4 6 FEET
GOTHAM 603A
PITTSBURGH RECESSED REFLECTOR E 500-S WITH HINGED CONCENTRIC LOUVERS - PLASTER RING 2-B 300W
PITTSBURGH RECESSED REFLECTOR 56-2 WITH HINGED EGGENTRIC LOUVERS FM-99-CA - PLASTER RING 54 200W
PITTSBURGH KNOCKOUT STRIP KO-1 200W NO. C-101-A
REFLECTOR LAMPS 150W ON PITTSBURGH CONDUIT NO. 1
DECORATIVE CHANDELIER

Figure 2. Plan view showing location of lighting equipment.

Illumination and brightnesses of typical areas are as follows:

Average illumination	
Top of sales table	38-47 footcandles
Merchandise displays	69-95 footcandles
China display	
horizontal	100-120 footcandles
60-degree plane	40-75 footcandles
Brightnesses	
High-lighted wall	35 footlamberts
Other walls	15-25 footlamberts
Floor	16-33 footlamberts
Table sides	3-12 footlamberts
Dishes on rack along wall	20-65 footlamberts
Ceiling	2-7 footlamberts
Dark side of beam	1-3 footlamberts
Luminaires (max. in 40 to 60-degree zone)	200-300 footlamberts

Architect: Harris Armstrong, St. Louis, Missouri.

Lighting data submitted by Carter Lewis, Union Electric Company of Missour, St. Louis, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, lighting problem and to aid in the design of similar installations.

An analysis of every phase of the seeing task was made prior to final design, and factors of good lighting carefully applied in the installation at the . . .

U.S. Geological Survey Building

By GEORGE E. MOEN

MANY peculiar seeing problems and conditions not typical of working areas in general, presented themselves in the design of the Denver Federal Center Geological Survey Building. Our analysis of the specific seeing tasks in the Base Sheet Preparation Area determined that a very high level of illumination was necessary, possibly 150 footcandles. The drafting-type work to be done involved fineness of detail, accuracy and speed. Further, however, instruments used in laying out the grid system were found to be specular, and quality of a high order was also required. Other considerations also involved in the lighting analysis were air-conditioning requirements and their relation to the size of the area. To prevent map paper from expanding and contracting, temperature and humidity must be maintained at minimum variation.

The luminous ceiling used in the system provides a barrier for the heat generated by lamps, ballast and steel pan roof. The steel pan roof is exposed to the Colorado sun and will build up temperatures of 130° during the day. In order to remove the heat generated in the cavity, the surplus air taken in by the air conditioning equipment from the outside is exhausted through the corrugated translucent acrylic plastic panels, then circulated in the cavity and exhausted through the roof. In winter season the heat generated will be controlled and used as a barrier against the cold steel pan roof. These operations will place a minimum load requirement on the air-conditioning equipment through the different seasons both from the standpoint of the heating and refrigeration functions of the unit.

Design Calculations and Survey Data

The quantity of light for the subject area was calculated by use of the Lumen Method for General Lighting Design using coefficients of utilization for bare lamps and allowing for the efficiency of the cavity ceiling and translucent acrylic plastic panels. It was determined that approximately 150 footcandles would be required for this particular seeing task.

Room dimensions were:

Length 110 ft. 11 inches; Width	88 ft. 10 inches
Area (Actual)	9,710 sq. ft.
Height to Plastic	8 ft. 6 inches
Depth of Cavity	3 ft. 5 inches

Reflection Factors were as follows:

North Wall (Light green)	43 per cent
South Wall (Light green)	55 " "
West Wall (Light green)	55 " "
East Wall (Light green)	55 " "
Cavity Ceiling (White)	79 " "
Floor (Tile) (Light tan)	34 " "

Translucent Acrylic Plastic Panels Transmission Characteristics:

Nonreflecting Cavity	54 per cent
80 per cent reflecting cavity	85 " "

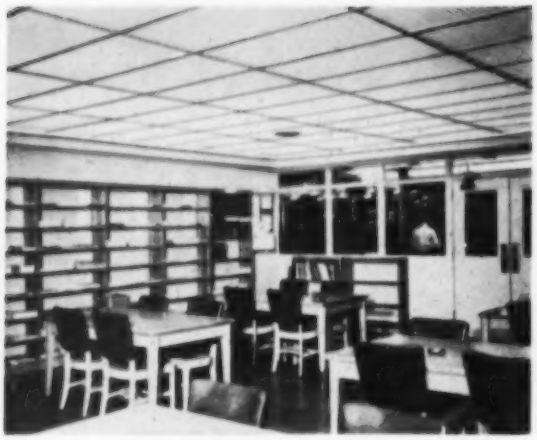
Lamps used were:

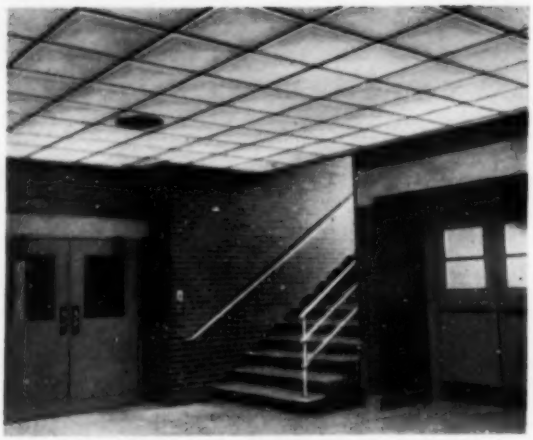
79 — 55w72" (Standard Cool White)	425 M.A.
713 — 74w96" (Standard Cool White)	425 M.A.

Lamps located on 18-inch centers 12 inches from plastic panels.

Base Sheet Preparation area.

AUTHOR AND DESIGNER: Denver Federal Center, U. S. Dept. of Interior, Denver, Colo. Submitted through Papers Reporter, Rocky Mountain Section.





(Left) Library reading room. Area at rear still under construction. (Right) Lobby.

The following calculations were made from the stated requirements and data:

RM Index A; M.F. — .75; C.U. — .66

$$F.C. = \frac{\text{Lamp Lumens} \times \text{C.U.} \times \text{M.F.} \times \text{T.C.}}{\text{Area}}$$

$$F.C. = \frac{3{,}706{,}050 \times .66 \times .75 \times .85}{9{,}710}$$

F.C. — 162

Illumination Measurements:

July 15, 1953	163 ft-c at center of room
November 17, 1953	148 ft-c at center of room

Average Brightness Readings and Ratios to Task:*

Area	*Ft-L*	*Ratio to Task*
1. Task (White drawing paper)	120	
2. Luminous Ceiling	170 side	1.4 - 1
3. Luminous Ceiling	175 center	1.5 - 1
4. Luminous Ceiling	145 end	1.2 - 1
5. Tee-bar	38	3 - 1
6. Lower Side Wall	40	3 - 1
7. Upper Side Wall (Glass panel)	24	5 - 1
8. Anemastat	34	4 - 1
9. Floor (Asphalt tile)	27	5 - 1

Library Reading Room

A luminous ceiling was also used in the library reading room. In all details of this room, care was used to provide a uniform distribution of illumination, free from direct or reflected glare, shadows and sharp brightness contrasts. Light, pleasing colors were used on all surfaces. The problem of the dark bookends (as noted in the picture) is still under consideration.

For this ceiling, standard warm white slimline lamps are mounted on 24-inch centers. Initial illumination was 65 footcandles at the center of the room, 30 inches above the floor. Brightness readings and ratios to task were found to be:

Area	*Ft-L*	*Ratio to Task*
1. Task (White paper)	44	
2. Luminous Ceiling	81	1.9 - 1
3. Anemastat	16	2.7 - 1
4. Wall	20	2.2 - 1
5. Floor (Light cork)	19	2.3 - 1
6. Desk (Light wood)	30	1.4 - 1

Lobby

Conformance with design of the area, rather than visual requirements, dictated the use of plain acrylic plastic panels to form a luminous ceiling in the lobby of the building. Initial illumination measurements, however, were 50 footcandles at the center of the room, with comfortable brightness ratios. Brightnesses were, for example, of the order of 87 ft-L for the luminous panels; 15 for the light red brick wall; and 14 ft-L for the light gray terrazzo floor.

Conclusion

Relamping and cleaning schedules are at present being worked out, since it is felt important to maintain the light surfaces for high quality, as well as continuing high levels of illumination. All furniture moved into the area, desks, drafting tables et al, have first been painted a light tan color, to maintain the desired brightness balance.

*Measurements taken with Luckiesh-Taylor brightness meter.

INSTALLATION ON DELAWARE MEMORIAL BRIDGE, SOUTH OF WILMINGTON.

Lighting a Bridge

LIGHTING OBJECTIVE: To provide a dependable, attractive and easily maintained lighting installation permitting safe and rapid movement in an area of high traffic density.

GENERAL INFORMATION: This $44,000,000 bridge stretches 10,765 feet across the lower Delaware River, linking U. S. Routes 13 and 40 in Delaware with U. S. Routes 130, 40, and the New Jersey Turnpike in New Jersey. The total length of the bridge, including approaches, is 18,265 feet, and it has a main span length of 2150 feet, the third longest suspension span in the United States and the sixth longest in the world. Designed for an estimated yearly traffic volume of 4,000,000 vehicles, this bridge carried by actual count 10,000,000 vehicles during the first year of operation. The roadway is 51 feet wide with a three-foot medial strip separating the opposing lanes of traffic. The road surface is concrete.

The proximity of the bridge (with its 440-foot towers) to the New Castle County Air Base emphasized the necessity for dependable service. Prolonged darkness of the bridge could prove hazardous to planes and ships.

INSTALLATION: Westinghouse AK-10 luminaires having an I.E.S. Type III distribution are suspended on 4-foot bracket arms, at a height of 27 feet, from twin-light round steel standards

(over)

A.I.A. File No. 31

Figure 2. Daylight view.

mounted along the three-foot medial strip separating the traffic lanes. The auxiliary reflector (house shield) was eliminated from the luminaires to increase the lighting in the off-lanes and minimize the effect of an individual lamp outage. The standards are spaced 90 feet apart. Ten-thousand lumen, 20-ampere, street series lamps are used. To ensure maximum reliability, safety and easy electrical maintenance, a 6.6-ampere series system, using a 6.6 to 20-ampere isolating transformer for each lamp, was chosen for the 2.04 miles of the bridge proper.

Based on 9390 mean lumens over rated life of the lamp and allowing a 20 per cent maintenance factor, the calculated illumination level maintained in service will be 1.0 footcandle.

Lighting designed by Howard, Needles, Tammon and Bergendoff, Consulting Engineers with assistance from the Delaware Power and Light Company, which provides the electrical service, and W. H. Hyatt, Westinghouse Lighting Engineer, New York.

Lighting data submitted by J. H. Wenner, Street Lighting Engineer, Middle Atlantic District, Westinghouse Electric Corporation, Philadelphia, Penna., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Progress in Television Studio Lighting

Supplement to 1951 "Current Lighting Practice for Television Production."
Prepared by the I.E.S. Committee on Television Production Lighting

Part I—Television Production Lighting

TELEVISION studio production lighting differs from motion picture studio production lighting in several important respects. These major differences can be summarized as follows:

1. The practical contrast range for operational use is 20:1 for television cameras, whereas ordinary photographic films will reproduce contrast ranges of 100:1 or higher.

2. In television, the final picture can be seen on a monitor before going on the air, whereas in the motion picture industry, the film must be developed before there is proof of a good picture.

3. From point 2 above it is seen that during rehearsals, using a monitor and "A" scope* as a guide, it is possible within the time available to adjust the lighting equipment to obtain and be certain of an acceptable picture.

4. Television action is continuous, whereas in film production scenes are taken in whatever sequence desired and as much time spent on an individual scene as may be necessary; later, the film is edited. However, the continuity of action in an hour of television production requires that the lighting must be such that the correct picture is produced by each of the several cameras used, without stopping and resetting the lighting for the various camera angles, close ups, long shots, etc. Once the show is on the air, no physical adjustment of the lighting equipment is made, and only switchboard dimmer controls are used.

Spacing of Outlets

Several definite trends in equipment requirements and application have developed since the 1951 report.[1] In production back-to-back studios, it is desirable to have overhead lighting outlets on centers two feet apart in rows four feet apart, and it would be ideal if the battens supporting the lighting equipment were four feet long, with individual raising and lowering devices. Economically, this is not feasible, and battens 15 to 20 feet in length are used, with individual raising and lowering devices for each light desirable. Recommended outlet spacing for dramatic shows and smaller studios is 12 to 16 square feet per outlet (in rows six feet apart and outlets on approximately two-foot centers).

Dramatic Lighting

For dramatic lighting, the tendency is to the wider use of fresnel lens type equipment both for "pin-point" effect lighting and in the "wide beam spread position" for general base lighting. This, however, does not preclude the use of scoops—which are still the work-horse of the studio for base and some fill light. In a number of instances, particularly as mentioned above, the controlled adjustable wide beam lighting of the fresnel spot is very useful and desirable, particularly because it permits the use of "barn doors" to pattern the light and to cut off the unwanted part of the beam. These units should produce as uniform a beam pattern as is possible, free from hot spots or marked differences in intensity. Black lens risers are favored to reduce stray light.

Beam Control

Considerable experimenting is being done to produce units which will have a height to width ratio of 1:2 with the desirable characteristics of uniform beam pattern and the ability of using four-way "barn doors" for shaping the beam.

Fluorescent Base Lighting

The use of fluorescent base lighting equipment is in a state of flux among the larger studios, particularly for production back-to-back studios. Fluorescent base lighting is believed desirable and recommended for the smaller studios.

Dimming

Desirable pictures are the result of both lighting intensity and video control. Within-scene changes are produced by lighting, which is most satisfactorily controlled through the use of dimmers. The

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A report approved by the Council of the Illuminating Engineering Society, April 1954.

*The "A" scope is the cathode ray tube used to determine the amplitude and other waveshape characteristics of the video signal.

1. "Current Lighting Practice for Television Production," ILLUMINATING ENGINEERING, September 1951, p. 494.

Figure 1. Typical television studio lighting at WWJ-TV, Detroit, Michigan. Note the bank of fluorescent lamps in the center.

Figure 2. View of television studio down through the lighting pipes. This scene uses 25 lighting units: eight scoops (floods) out front, ten 500-watt spots, six 1000-watt spots and one 2000-watt spot.

Photos at right and below courtesy of the *Journal of the Society of Motion Picture and Television Engineers.*

Figure 3. Another view of scene shown in Fig. 2. At the top of photo are the scoops which provide base light. On two 1000-watt spots "barn doors" have been used to create the dark uppers and light bottoms on the two doors. The bars on the window are projected through by means of a 2000-watt spot which puts bars on the curtain, showing there is some light outside. The walls of the set are lighted with one set of lights and put on one dimmer. Actors are backlighted to make them stand out from the walls and the backlights are on another dimmer. The base, or the flat front-fill, light is on a third dimmer. Key lights to give the character and shadows to actors are on a fourth dimmer.

increasing use of dimming equipment permits the use of higher wattage lighting equipment, warranting a sufficient lighting level from any unit for the largest of productions. In black and white television, dimming to any lower level is a common practice. Experience gained over the past few years proves the advantages of dimming equipment; the time consumed in lighting a set is very greatly reduced when dimmers are employed, and the picture quality is far superior.

Part II—Illumination Measurements

Illumination instruments measure incident light and consequently do not take into account the reflection factors of the scene components; illumination measurements are not indicative of scene brightness contrast.* However, an illumination meter in the hands of an experienced person can be a very useful tool. Extreme contrasts can be eliminated, and exposures can be based upon measurements of illumination.

*The brightness of a surface is the product of the incident illumination and reflectance (lightness) of the surface.

Incident Light

Illumination base levels may range from approximately 35 to 150 footcandles depending on the condition of the camera tube, the effect desired and the color value and reflectance of the scenery. Highlighting, back lighting, etc. values may run 50 to 100 per cent higher, again depending on the effect desired and the subject matter.

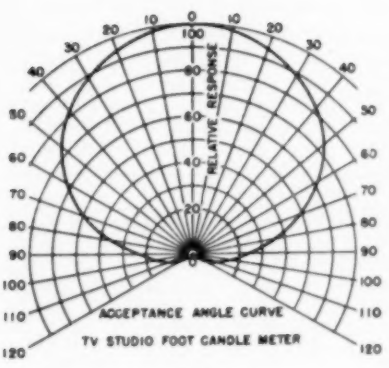
Scene illumination is usually the result of key, fill, base and/or back lighting. For this reason, it is highly desirable that the illumination meter shall have acceptance characteristics that give proper weight to light incident at oblique angles.

Fig. 4 shows a small and readily available meter** with two scales: 0 to 300 and 0 to 1500 footcandles. A special light collector is provided to integrate properly illumination from angles in excess of 180 degrees.

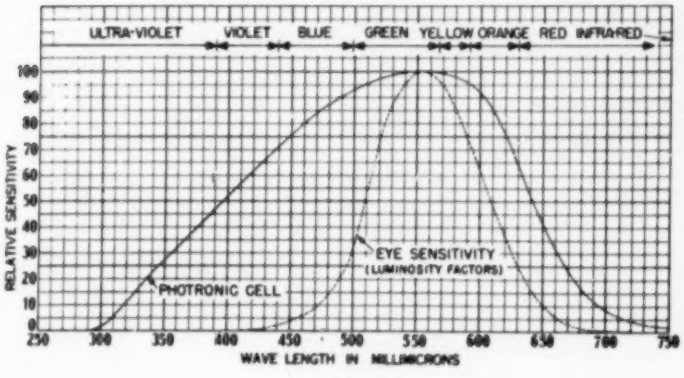
**Weston Model 915.

(a)

(b)



(c)



(d)

Figure 4.

(a) and (b) Footcandle meter designed for television studio use.

(c) Acceptance angle curve for meter.

(d) Spectral sensitivity of meter.

Figure 5. New electronic brightness meter developed for television studio use.

Brightness Measurements

Brightness instruments measure the average brightness of discrete areas. The size of the included area is dependent upon the acceptance angle of the meter and the distance between the meter and the scene. Since each discrete area is effectively a source of light to the television camera, a measurement of the lightest area and the darkest area immediately gives a means of determining the contrast ratio, the ratio of maximum brightness to minimum brightness. Thus, by means of these two brightness measurements, the key and fill lights can be so arranged that the contrast ratio can be held to any desirable value.

With the contrast ratio controlled to a tolerable limit, the exposure can be based on the minimum, maximum or average brightness of the scene area. The average brightness value can be determined from the minimum and maximum values, or the overall scene brightness can be measured by having sufficient distance between the meter and scene so that the meter integrates all of the light and indicates the average brightness directly.

The meter shown in Fig. 5* has been developed especially for television studio use. It has a sensitivity range of 0.1 to 1,000,000 footlamberts, covered in six steps, and an acceptance angle of approximately two degrees.

*Spectra Brightness Spot Meter, manufactured by Photo Research Corp., Burbank, Calif. See "Design Characteristics of a Photo-Electric Brightness Meter," by Karl Freund, ILLUMINATING ENGINEERING, October 1953, p. 524.

Balance

Recent observations in network television studios indicate that television lighting engineers are increasingly referring to monitor sets and "A" scopes for guidance in determining the quality and quantity of illumination of a given scene. With the fresnel spots, scoops and other pieces of lighting equipment installed at current practice spacings referred to above, an experienced television lighting engineer can lay out in advance the lighting scheme required for each scene. He can quickly direct the placement of the lighting units and their adjustment to produce the proper base, key, back and highlighting, and by referring to a monitor and "A" scope he can by his dimmer controls arrive at the final intensity per unit to produce the necessary balance.

During a multi-scene production, it is important that scenes having the same key level be so illuminated that the cameras shifting from scene to scene will produce the correct picture. An illumination meter is a valuable tool during set up time to quickly check these levels so that the final results will be as desired.

Where dimmer control is not available the correct balance is more difficult to achieve and a brightness meter will be of assistance in the initial stages of lighting a set. The monitor and "A" scope are used as a guide for the very final adjustments. To make these final adjustments, without the use of dimmers, requires the physical handling of the equipment, which generally causes loss in rehearsal time.

I.E.S. COMMITTEE ON TELEVISION PRODUCTION LIGHTING

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TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Preview of Plans Revealed By Atlantic City Conference Committee

A quick look at what's afoot for the Atlantic City Conference in September indicates a program of events of interest to everybody. Serious-minded, and not so serious.

Entertainment

A completely free dividend for the conference planners, and of course those attending, is a triumverate of circumstances with very happy results. In addition to the Beautiful Sea (at its best in September) it so happens that Atlantic City is the center of the celebration of Light's Diamond Jubilee. The goings-on for this event will never be equalled — or not for another 25 years. It will really be something to see — and remember always.

In addition to that, this year is also the one-hundredth anniversary of the founding of Atlantic City. The entire city is going all out in its Centennial Fete. Here again, this event alone will be worth the trip.

The I.E.S. conference in itself, however, will be equally attractive. The committees have arranged features for both business and fun; from the looks of them topping all previous conferences. Serious business, committee meetings and papers sessions are, of course, the purpose and value of an I.E.S. conference. Reference to the list of sessions scheduled should confirm this. Between times, however, the committees have planned a number of light-hearted events everyone will enjoy.

Sunday evening, for instance (September 13) there will be an "Early Bird Buffet Dinner" at which early arrivals will get acquainted right from the start.

Chalfonte-Haddon Hall
By the Beautiful Sea

A rollicking "Ship Wreck Party" is scheduled for Monday evening, planned by the host Section, Philadelphia. How to dress? Dungarees and tee shirts for both male and female, or any other raggedy patched-up clothes. Such costume is prerequisite to admittance, by the way. There will be dancing with music furnished by the hotel orchestra, and entertainment provided by a "Mr. I.E.S. America" contest.

The "Mr. America" contest will be a farcical take-off on the well known Miss America beauty pageant, with picked male entries from the Sections and Chapters. This we'll have to see!

Space is arranged following business sessions Wednesday afternoon for golf and boat trips. A committee will be on hand too, to help with deep-sea fishing for those so inclined, as well as horse racing and ocean bathing.

The banquet will be on Thursday evening, September 16. From all accounts it will be a brilliant affair.

Amateur Photography Contest

Bring your camera to Atlantic City. The Amateur Photography Contest sponsored by the conference may bring rich rewards. Art Brainerd is in charge of this, and has made arrangements for all kinds of photographic supplies to be easily available right at the hotel. Look for the contest booth and see Art Brainerd for all details.

Special for Ladies

The program at Atlantic City, plus the proximity of New York and Washington will bring a record attendance of ladies, undoubtedly. The planning committees apparently feel this is so, and are ready with a full program. There will be a trip to an Orchid Farm, for instance, with luncheon out there Tuesday. Another luncheon is featured Thursday, with a Millinery Style Show. There will be an antique display at the Smithfield Inn and something to do that's pleasant every day.

Technical Program

In the papers program an innovation of value to all will be the "Environment" session (Functional Lighting). Here top speakers, some from abroad, will discuss each element of an interior—heating and air-conditioning—sound—color—lighting—architecture and decoration—and how they may be correlated one to the other. An open Forum following this session should be rich in ideas, and certainly stimulating to many branches of interior planning.

Outstanding papers have been submitted for the program this year. In addition to the Environment session, there will be nine other sessions (some of them parallel). Details of these are given in the program at the end of this report.

The Progress Report this year is also a must. Plans for this have been in re-

Watch for Advance Registration Forms

Due in the mail shortly are Advance Registration blanks for the National Technical Conference. Get yours in Early.

Time: September 13-17, 1954

Place: Chalfonte Haddon-Hall Hotel
Atlantic City, New Jersey

hearsal since last winter, and the Atlantic City attendees can look for a show packed with interest and entertainment. In celebration of Light's Diamond Jubilee, theme of the report will be history, progress, and the future. An interesting lamp display of pre-electric light sources, together with the world's largest lamp and the world's smallest, will be part of the exhibit.

The following papers will be presented during the technical sessions. Preprints will be available at the registration desk. Those wishing to present discussions immediately following the paper may get in touch with the Papers Committee Chairman, Dr. R. M. Zabel, % Westinghouse Electric Corp., Bloomfield, N. J.

Environment Session

The Acoustic Environment — Robert B. Newman, Consulting Engineer.
The Thermal Environment — Nathaniel Glickman, Consulting Engineer.
The Luminous Environment — L. C. Kalff, N. V. Philips, Eindhoven.

Light Sources and Controls

Short-Arc Xenon Lamps—Wolfgang E. Thouret and George W. Gerung.
Determinants of Fluorescent Lamp Life—R. N. Thayer.
Some Problems Involved in the Design of Fluorescent Lamps — Erwin F. Lowry and W. Calvin Gungle.
Ballast Applications — James H. McCulloch.
Cold Cathode Lamp Characteristics — B. F. Greene.

Residence Lighting

An Analysis of Twelve Solutions to a Home Lighting Problem — George Danforth, Laurence Schmeckebier and Karl Staley.
Home Lighting and Home Decoration — C. Eugene Stephenson.

Quantity and Quality

Quantity of Light — H. R. Blackwell
Quality of Lighting — S. K. Guth
Color and Seeing—Harry Helson

Lighting Calculations

Brightness and Illumination in Enclosures — R. S. Wiseman.
A Lumen Method of Daylighting Design — W. J. Arner, E. W. Conover, and J. W. Griffith.
Measured Utilization Factors — W. M. Potter and A. N. Russell.
Exterior Illumination versus Interior Illumination Distribution — W. H. Billhartz, H. F. Kingsbury and R. W. McKinley.

Street Lighting

Electric Discharge Lamps in Street Lighting Service — J. W. Young.
Operation of Mercury Vapor Lamps on Series Lighting Circuits — W. A. Oglesbee and M. E. Keck.
Characteristics of Ballasts and Their Influence on Mercury Lamp Starting — J. R. Morin.
The Influence of Jubilee Lighting on Street Lighting—W. Earle Hawkins, E. W. Beggs and Dana Rowten.

Work Area Lighting

Lighting a TV Set Assembly Plant — R. M. Smart and Willard Allphin.
Economic Lighting for Today's Industry — W. H. Kahler and D. W. Rowten.
Lighting in the Richmond Postoffice — C. E. Kautt and T. C. Cargill.

Applications and Civilian Defense

Church Illumination for the Various Types of Services — J. M. Ketch.
Floodlighting and Decorative Lighting — R. A. Eshelby.
Symposium Lighting for Civilian Defense — Barnet Beers, Phillip Batson and J. C. Forbes.

Plastics and Lighting Interests Meet Study Committee Formed

Mutual interests of lighting equipment manufacturers and plastics processors were discussed at a recent meeting in Cleveland attended by 29 top men in both fields. A most constructive forum resulted from the airing of problems and needs on both sides.

Best approach to the solution of the several problems cited was a priority system, with organized study of the most pressing. Three sub-committees were established under a Joint Committee on Plastics for Lighting, one of illumination personnel for the lighting industry's needs, one of men from the plastics industry, and a joint group to study maintenance. The group voted as chairman of the main committee Eric H. Church, Benjamin Electric Mfg. Company, Des Plaines, Illinois.

First undertaking of the lighting sub-committee will be the study of minimum requirements of plastics for lighting, the sub-committee being charged with the following responsibilities: "Cite the requirements of the lighting industry of plastics materials for (a) side panel diffusion, (b) bottom panel diffusion, (c) louvers. The information should cover fixtures and wall-to-wall ceiling requirements. In addition the committee shall cite the condition under which the fixtures are used; that is, environmental information." W. P. Lowell, Jr., Sylvania Electric Products Inc., was appointed Coordinator of this lighting sub-committee, and George Gilleard, Curtis Lighting Inc., was made Chairman.

The plastics group for their initial assignment will prepare a report and recommendations on test methods which may exist for measuring accelerated aging, light transmission, dimensional stability, hiding power, and thermal stability. Both the plastics sub-committee and the lighting sub-committee will work concurrently in developing their respective recommendations.

Another immediate need was found to be the organization of a maintenance study group and Chairman Church asked a special sub-committee to obtain data on and for inclusion in a maintenance manual. Among the things to be considered by this sub-committee will be how to wash and take care of lighting fixtures using plastics, what de-staticizers may be used, etc. F. W. Ogden, The Miller Company, Meriden, Conn., was appointed chairman of this group.

At some time in the future, it was agreed by the joint group, it will be necessary for the Committee to consider the adoption of some sort of labeling system. Pending the completion of current studies of the Standards Committee on a labeling or hallmark system, Messrs. W. T. Cruse of the Society of the Plastics Industry, C. L. Crouch of the Illuminating Engineering Society, and E. H. Salter of Electrical Testing Laboratories, agreed to study the possibility of setting up a quality control system.

Establishment Announced of I.E.S. of India

The establishment of an Illuminating Engineering Society of India has been announced by its Honorary Secretary S. N. Chowdhry, of Calcutta, India. The first issue of the *Journal* of the Society will contain the Rules and Regulations of the organization, part of which have been based on the experience of the American I.E.S.

In a message of good wishes to the new organization, President A. H. Manwaring has said:

"Your fellow Illuminating Engineers in America extend their congratulations to you and your new Illuminating Engineering Society.

"The Illuminating Engineering Society of America was established in 1906 for the 'advancement and dissemination of the knowledge of the art and science of illumination.' Through the years we have always endeavored to carry out this principle. It has further been our earnest desire to assist in every way possible the development of new Illuminating Engineering Societies. To that end we offer you any help you may require in the early establishing and operating of your new Society. We shall be pleased to make available to you copies of any technical manuals, standards or committee reports that may be of value to you in the work of your organization.

"As President of the Illuminating Engineering Society of America, I take this opportunity of wishing you the greatest success in this new and most important undertaking. I know you will make a great contribution to your country as you promote finer illumination for the people of India."

Retail Industry Show Announced for Next January

A National Retail Industry Show, to serve the modernization, construction and equipment needs of retail stores, has been announced for January 7-11 at Madison Square Garden, New York City.

The show, sponsored by the Store Modernization Institute, will be combined with the Fifty Store Modernization Show, which in the past has been held in June.

Southwestern Regional Conference offered diversified program to packed sessions. Some of the 140 delegates attending are shown at one of the technical sessions held at the Rice Hotel, Houston, April 11-13.

Houston Features Texas-Style Regional Conference for Southwest

There's a certain way of doing things in Texas. If you don't think so, just go to one of their Conferences. The Southwest Regional in Houston, for instance, wasn't the biggest of all the Regionals. Registration was about 140. Its program was mighty good; so were many others. A certain spirit they put into things, though, is as intangible as it is unmistakable. The 140 people who attended their Conference at the Rice Hotel April 11-13, enjoyed every minute of a very fine program.

The "intangible" in the papers program was the purposely diversified nature of the talks. There was literally, something for almost everybody. Lighting engineers and architects particularly, would have found material rich in ideas from the talk by Walter T. Rolfe, for instance. Mr. Rolfe, a Houston architect, is a Fellow of A.I.A. and a U.N.E.S.C.O. representative for architecture at the United Nations. It was especially interesting to the Houston I.E.S. audience, to hear his inspiring ideas on what the architect is trying to do, and the important role of the lighting man in this effort. He stressed the need for more public education, so that the aims of the architect and the illuminating engineer will be more widely accepted.

In the keynote address by Frank M. Austin, Vice-President in Charge of Commercial Operations, Houston Lighting and Power Co., further emphasis was laid on the new role of lighting arising from air-conditioned homes. Mr. Austin, one of the first lighting engineers in Texas, told of the early problems of illuminating engineering, with the limited tools and measuring devices available in his day. The work of I.E.S., he felt, is the dominant factor in the mass of information available to the lighting engineer of today.

The Rolfe and Austin lectures were, of course, but two of fifteen excellent talks, details of which are given at the end of this report.

While the Conference opened officially on Monday, April 12, actually events were rolling as early as Sunday afternoon. A Local Activities meeting was followed by a Reception and Cocktail Party for President Manwaring Sunday evening. The Conference Committee was host at this affair, which was attended by almost the entire registration.

Following Mr. Austin's keynote address, clockwork precision by some unidentified hero on the arrangements committee kept the program right on schedule from this moment onward. This is a break for the closing speaker. In Houston, even the last lecture of the session was given before a maximum audience.

Mayor Declares Lighting Week

The I.E.S. in this Region enjoys considerable stature and civic pride. In honor of the Conference, the Mayor of Houston declared April 11-17 "Lighting Week." The official proclamation of this event was read to the delegates by George Trotter, Conference Chairman at the opening session. In connection with "Lighting Week" the Mayor also officially turned on the new street lighting installation in Houston, a civic celebration attended by vast throngs of Houston citizens, and featuring floats and colorful demonstrations.

Seen at the Southwestern Regional are l. to r.: George Trotter, Conference Chairman; Marshall Waterman, I.E.S. General Secretary; F. M. Austin, Houston Lighting and Power Co. who made keynote address; A. Homer Manwaring, National I.E.S. President; Gordon E. Brown, Chairman of the host Section, San Jacinto.

Chatting over coffee are a group of the 50 ladies who attended the Southwestern Regional Conference. A full program of entertainment was provided for them throughout the three-day meeting.

I.E.S. President and Mrs. Manwaring together with many I.E.S. delegates attended this event.

M.M.I.L.J.

The Houston program featured the contest "My Most Interesting Lighting Job" as their closing event Tuesday afternoon. Nine entries competed for the honor of representing the Region at the Atlantic City finals. This represented one from each of the Region's five Sections and Chapters, and four from outlying cities in which I.E.S. is also an active force. The Board of Judges chose:

First Prize: Floyd Covington, Jr., Post Engineers, Ft. Sam Houston, Texas. Alamo Section. Lighting a Drafting Office.

Second Prize: Harry G. Hrivnatz, Houston Lighting & Power Co., Houston, Texas. San Jacinto Section. Remodeled Office Building.

Third Prize: Richard A. Landry, Gulf States Utilities, Port Arthur, Texas. San Jacinto Section. Small-town bank.

Other interesting entries were presented by M. H. Perkins, Texarkana, Ark., with a High School Athletic Building. Thomas A. Hart, Amarillo; Lighting a Drive-In Resaurant. William Simpson, Houston; Residential Lighting. L. T. Anderson, Dallas; Jewelry Store. Carlton C. Whitworth, Corpus Christi; Church Lighting.

Judges for the Southwestern Regional contest were Gordon Brown, M .J. Myers, N. O. Reid, W. T. Kimmery and Ruby Redford.

ENTERTAINMENT

For the men present, the Houston program was too valuable to miss during the session programs. The ladies, however, of which some 50 were present, had a wonderful time. Local Committee members' wives were obviously no less busy, with their plans for the women's program.

In addition to the pre-conference cocktail party and the banquet-dance, the ladies had coffee aboard the yacht *Sam Houston*, and a morning sail on the Houston Ship Channel, as a start. Tuesday noon they had lunch at the fabulous Shamrock Hotel, in a delightful spot overlooking the shamrock-shaped pool. The hotel management allowed them to satisfy their curiosity on what a $300.00 suite might look like, by conducting the party throughout the hotel, including the roof promenade. Car pools were formed for this trip, and a tour of Houston, under the direction of Mrs. Merrill Wright, Mrs. Harry Hrivnatz and a number of hospitable local I.E.S. ladies.

The men too had their fun. Luncheons were scheduled both days, one held jointly with the Houston Engineers Club. And, of course, the President's dinner dance Monday evening. At this affair, President Manwaring was made an honorary citizen of Texas, receiving the traditional ten-gallon Texas hat.

PROGRAM

For the record, a detailed list of the program was:

Sunday, April 11, 1954

Local Activities Meeting — South American Room No. 1.

President's Reception and Informal Cocktail Party — South American Room.

Monday, April 12, 1954

Chairman—G. E. Brown, General Electric Co., San Antonio, Texas.

Conference Convenes—South American Room No. 1.

Greeting — Frank M. Austin, Vice-President in Charge of Commercial Operations, Houston Lighting and Power Company, Houston, Texas.

Lighting for Varied Requirements of Shopping Centers — C. M. Cutler, General Electric Company, Cleveland, Ohio.

Street Lighting Program for Houston — H. G. Hrivnatz, Houston Lighting & Power Co., Houston, Texas.

What an Architect Can Do for an Illuminating Engineer in Lighting Problems—Walter T. Rolfe, Architect, Houston, Texas.

Lighting Is Protection — H. L. Logan, Vice-President in Charge of Research, Holophane Company, New York.

I.E.S. Luncheon — Rice Hotel, South American Room A.

President's Report — A. H. Manwaring, President, I.E.S.

Monday Afternoon — April 12

Chairman — W. T. Kimery, Dallas Power & Light Company.

Classroom Lighting and Economics — R. D. Burnham, Wakefield Brass Co., Vermilion, Ohio.

Ballast and Circuit Control Devices — M. E. Robertson, Jefferson Electric Co., Bellwood, Ill.

A Bushel of Light — C. L. Crouch, Technical Director, Illuminating Engineering Society.

Report — M. J. Myers, I.E.S. Southwestern Regional Vice-President.

Monday Evening — April 12

Dinner Dance — South American Room, Rice Hotel.

Tuesday Morning — April 13

Chairman — J. C. Pennafeather, Leon B. Senter Co., Tulsa, Okla.

Lighting Highlights — T. C. Sargent, Sylvania Electric Products Inc.

Reports on the other Regional Conferences — held during April, May and June — will appear in forthcoming issues of I. E.

Highlights of the Jubilee Activities and Their Implications — S. G. Hibben, Westinghouse Electric Corp., Bloomfield, N. J.

Light and Color — James A. Meacham, The Sherwin-Williams Company, Cleveland, Ohio.

Lunch with Houston Engineers Club—Ballroom.

Address—A. H. Manwaring, President, I.E.S.

Tuesday Afternoon — April 13

Chairman — N. O. Reed, Day-Brite Lighting Inc., Houston, Texas.

At Home with the Society's Newest Practice—Mary E. Webber, General Electric Company, Cleveland, Ohio.

Competition to Determine Winner of "My Most Interesting Lighting Job" Contest.

CREDITS

Committee members rating great credit for the success of the Houston Conference are:

G. S. Trotter—General Conference Chairman

G. A. Peabody—Finance Committee

E. C. Ober, Chairman—Ladies Entertainment Committee

H. D. Weisser—General Entertainment Committee

B. L. Cook—Attendance and Reservations Committee

W. E. Simpson—Arrangements Committee.

British I.E.S. Holds Southport Conference

The Summer Meeting of the British Illuminating Engineering Society was held at Southport, England, May 18-21, with the following technical sessions held in Cambridge Hall.

Lamps and Their Uses — J. N. Aldington, Managing Director of Siemens Electric Lamps and Supplies Ltd., and Alfred Graham and Co. Ltd.

Street Lighting in a London Suburb — A. T. Durbridge, District Manager of Harrow District, Eastern Electricity Board.

Lighting for Plant Growth — A. E. Canham, Rural Electrification Section, British Electrical and Allied Industries Research Association.

Display of New Lighting Equipment — held at the Palace Hotel.

The Economics of Industrial Lighting Installations —
Hot cathode installation in a woolen mill—S. T. Clark, Henry Lister & Sons, Ltd.
Cold cathode installation in a large engineering factory — W. Howe, Donald Smith Seymour & Rooley.
High bay mercury in heavy engineering works — F. Jones, Babcock & Wilcox Ltd.
Blended light installation in steel works — G. W. S. Levey, McLellan & Partners.

The Decorative Approach to Commercial Lighting — Andre Claude, Chairman and Managing Director, Claude-Paz et Silva, and Past-President of Association Francaise des Eclairagistes.

Home Lighting — Arthur H. Young, Director, Troughton & Young (Lighting) Ltd.; and C. J. Misselbrook, Manager, Troughton & Young.

A number of factory visits were arranged for the delegates to the conference, and there were numerous social events, including a Civic Reception and a reception by the Society President, Mr. W. R. Stevens.

LIGHTING CALENDAR

Society Events

June 17-19, 1954—Midwestern Regional Conference, Jefferson Hotel, St. Louis, Mo.

September 13-17, 1954—Illuminating Engineering Society, National Technical Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

Industry Events

June 20-24, 1954 — The American Society of Mechanical Engineers, Semi-Annual Meeting, William Penn Hotel, Pittsburgh, Pa.

June 21-25, 1954 — American Institute of Electrical Engineers, Summer General Meeting, Los Angeles, Calif.

July 13-15, 1954 — Western Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif.

September 1-16, 1954—International Electrotechnical Commission, Golden Jubilee Meetings, University of Pennsylvania, Philadelphia, Pa.

September 8-10, 1954—The American Society of Mechanical Engineers, Fall Meeting, Schroeder Hotel, Milwaukee, Wis.

September 22-24, 1954—Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont., Canada.

September 27-30, 1954 — Institute of Traffic Engineers, Annual Meeting, Hotel Muehlbach, Kansas City, Mo.

September 29 - October 2, 1954 — International Association of Electrical Leagues, Bellevue Stratford Hotel, Philadelphia, Pa.

October 4-7, 1954 — National Association of Electrical Distributors, Pacific Zone Convention, Mark Hopkins Hotel, San Francisco, Calif.

October 11-15, 1954—American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 17-22, 1954—Society of Motion Picture and Television Engineers, Semi-annual Convention, Los Angeles Ambassador, Los Angeles, Calif.

October 18-22, 1954—42nd National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

October 24-27, 1954 — Board of Governors, National Association of Electrical Distributors, Hershey Hotel, Hershey, Pa.

October 27-30, 1954 — National Electrical Contractors, Annual Convention, Jung Hotel, New Orleans, La.

November 8-11, 1954 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 15-17, 1954 — 41st National Foreign Trade Convention, Waldorf-Astoria Hotel, New York, N. Y.

November 15-17, 1954 — American Standards Association, 5th National Conference on Standards and 36th Annual Meeting, Hotel Roosevelt, New York, N. Y.

November 28 - December 3, 1954 — The American Society of Mechanical Engineers, Annual Meeting, Statler Hotel, New York, N. Y.

Recommendations Set Forth On Occupational Safety

The report of the Committee on Engineering of the President's Conference on Occupational Safety, held May 4, 5 and 6 in Washington, included twelve Recommendations, some of which are of particular interest to the lighting industry. They are as follows:

Recommendation No. 2 — Engineers and architects should develop and apply standards for safe and efficient plant layout, including adequate space for production operations, plant traffic and materials handling, and adequate storage space for raw material, finished products, and particularly for "in process" materials and tools.

Greater consideration to safety, health and sanitation in space utilization, and employee service areas, as well as to the factors of safety in building strength should be given in original design and construction and in remodeling of all industrial structures.

Recommendation No. 3 — While the relationship between high efficiency and effective accident prevention programs in industry has been established, additional studies, including substantiating data should be developed to emphasize this relationship in industry today.

Additional methods should be determined to convince management of all industries, regardless of size, that in addition to their legal responsibilities for safe operations and safe work environment, effective accident prevention programs are good business in creating improved public relations and in building high employee morale, as well as in reducing costs, waste and human suffering.

Recommendation No. 4 — All industries, both large and small, should develop and utilize to a greater degree a comprehensive preventive maintenance program.

(*Continued on page* 11A)

Chart Your Course for 1954 I. E. S.

NATIONAL TECHNICAL CONFERENCE

CHALFONTE-HADDON HALL

ATLANTIC CITY, N. J.

SEPT. 13-17, 1954

The Philadelphia Section is arranging one of the most outstanding conferences in all I. E. S. history. A few of the events planned for you are:

Meetings
crammed with valuable information

Social Events
packed with fun

Sports
bathing, boating, golf, fishing, races

Special Program
for the ladies

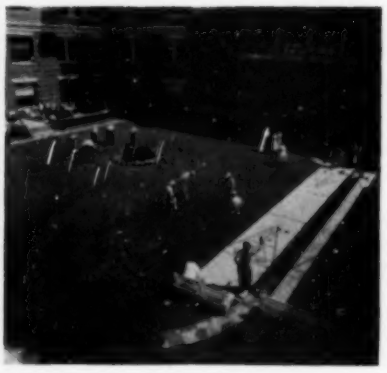
Spacious Hotel
luxurious living

Diamond Jubilee
electrical industry's celebration

Centennial
celebrating Atlantic City's 100th birthday

Transportation
convenient plane, railroad and bus routes

Vacation
ideal spot for family vacations



MICHIGAN Section Contest for My Most Interesting Lighting Job was held April 13. In photo at left Earl Domoney, Contest Chairman; Floyd Sell and Duncan Preston, who won first prize with a joint entry; and John T. Parks, Section Chairman. In photo at right are contest judges, Robert Dorsey, Alfred Paulus, and George Clark. The winning installations then went on to capture first place at the Great Lakes Regional Conference.

(*Continued from page 9A*)

Recommendation No. 5 — State regulatory bodies which promulgate and enforce safety codes should enact codes which are in conformity with recognized engineering practices such as set forth in American Safety Standards.

Recommendation No. 8 — Present engineering safety standards should be reviewed in relation to needs, and technical societies such as the American Society of Safety Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society of Civil Engineers and others are urged to cooperate with the American Standards Association in reviewing the adequacy of present American Safety Standards, and extending their work in this field.

French I.E.S. Conference Held in Monaco

The principality of Monaco was this year the site of the annual meeting of the Association Francaise des Eclairagistes, June 8 to 12. Numerous lighting installations and displays were a feature of the plans, and will remain on view during the entire summer season. The conference was held under the direction of the A.F.E. President, Y. Le Grand, specialist in the physiology of vision.

Theme of the program was "Light and Tourism," including such topics as illumination of monuments, of parks and gardens, sporting events, roadway and tunnel lighting. Fluorescent lamps were also discussed.

Filling Station Lighting Discussed at Chicago Clinic

Techniques for the lighting of gasoline filling stations were outlined at an all-day clinic held May 13 at the Chicago Lighting Institute. This was the first time this phase of lighting practice was the feature of a special clinic. Interest in it was evidenced by the attendance for the entire day, of some 150 station owners and oil company representatives.

Three groups sponsored the clinic: Chicago Lighting Institute, Chicago Section of I.E.S. and the Chicago Oil Men's Club. The meeting was held at the Institute under the direction of Carl W. Zersen. Joseph F. Herbenar of the Chicago General Electric office, was Chairman of the Conference Planning Committee who coordinated the program. W. H. Ganley, President of the Chicago Oil Men's Club and Vice-President of Falley Petroleum Co. served as chairman of the morning session. Dr. W. C. Witham, Specialist on Petroleum Technology of Armour Research Foundation presided at the afternoon meeting.

Especially popular with those attending was the question and answer period at the close of the meeting, which gave oil men an opportunity to clear up their most puzzling lighting problems.

The program began with opening remarks by Mr. Zersen, followed by:

Purposes and Objectives of Service Station Lighting—James R. Hinton, Jr., Marketing Engineering Dept., Shell Oil Co., New York City.

Lamps and Their Auxiliaries—George Jaeger, Lighting Engineer, Westinghouse Electric Corp., Chicago.

Lighting the Service Station Exterior — Robert T. Dorsey, Application Engineer, General Electric Co., Cleveland.

The afternoon session comprised:

Lighting the Service Station Interior — E. E. Elliott, Vice-President, Lighting Dept., Hawkins Electric Co., Chicago.

Wiring and Controls — John McLaughlin, Vice-President, Kelso-Burnett Electric Co., Chicago.

Maintenance of Service Station Lighting — Wallace Weld, Application Engineer, Revere Electric Mfg. Co., Chicago.

Quiz the Panel — Discussion Leader: Dr. W. C. Witham.
Panel members: Robert Besal, Steber Mfg. Co., Chicago; Wm. Akely, Guardian Light Co., Chicago; C. A. Petersen, Pure Oil Co., Chicago; Ted Mikita, Sylvania Electric Products Inc., Chicago; Anton Mayer, Buck Electric Construction Co., Chicago.

Summary — Eric Church, Director of Research, Benjamin Electric Mfg. Co., Des Plaines.

Home Lighting Institute Adopts Identifying Emblem

Development and adoption of a distinctive emblem for identification of members of the American Home Lighting Institute has been announced by its managing director, Miss Minita Westcott. The organization, comprised of home lighting fixture manufacturers, is currently engaged in a campaign to emphasize and publicize the benefits of installed home lighting for consumer, builder, contractor and architect.

The emblem shows a stylized figure holding a "sun" with the slogan "light for living" and the initials and name of the Institute. It is not intended as a seal of approval but as an identification of members with the national program.

(*Continued on page 12A*)

(Continued from page 11A)

Charter Meeting Ceremonies Held by Ark-La-Tex Chapter

The new Ark-La-Tex Chapter of I.E.S., which until now has been holding "pre-Charter" meetings, formally received its Charter and gavel at the dinner meeting May 3, in the Garden Room of the Captain Shreve Hotel, Shreveport, La. Attendance was 37 to see Regional V-P M. J. Myers present the Charter to Chapter Chairman R. K. Lothrop. The gavel, made and given to the Chapter by the next youngest San Diego Chapter, was presented by W. T. Kimmery, Chairman of the Southwestern Section, one of the "parent" Sections. Other guests attending were Harry Bailey, Chairman of the New Orleans Section (another parent Section), and J. E. Elliott, representing the Southwestern Gas & Electric Co.

HEAD TABLE dignitaries at the Charter meeting of the Ark-La-Tex Chapter, I.E.S., are, l. to r.: Paul Osteen, Vice-Chairman of the Chapter: W. T. Kimmery, Chairman, Southwestern Section; Mrs. M. J. Myers; M. J. Myers, Regional V-P; R. K. Lothrop, Ark-La-Tex Chapter Chairman; Mrs. Lothrop; Mrs. J. G. Harriss, Jr. and Mr. J. G. Harriss, Jr., Secretary-Treasurer of the new Chapter. In the photo below are shown some of the 37 in attendance at the meeting. Photos by Bill Brandon.

General Illumination Course Presented by Arizona Chapter

The Arizona Chapter of I.E.S. offered a General Course in Illumination, April 30 and May 1, at the auditorium of the Arizona Public Service Co. in Phoenix. Instructors for the classes were:

F. J. Rohring, Southern California Edison Co., Los Angeles, Calif.
J. R. Jones, Westinghouse Lamp Division, Los Angeles, Calif.
Donald T. Carter, General Electric Co., Lynn, Mass.
Carleton M. Thompson, San Diego, Gas & Electric Co., San Diego, Calif.
Ross Hendrix, Doctor of Optometry, Phoenix, Ariz.
P. G. Young, Western Clay Products Co., Phoenix, Ariz.
Dave Demaree, Consulting Electrical Engineer, Phoenix, Ariz.
J. D. Whitnell, Arizona Public Service Co., Phoenix, Ariz.
Bevan Jones, Arizona Public Service Co., Phoenix, Ariz.
William Downey, Arizona Public Service Co., Phoenix, Ariz.

The first three-hour session, held on the evening of April 30, opened with a welcome from W. P. Reilly, vice-president of Arizona Public Service, and an introduction to the course by Study Club Chairman J. D. Whitnell, followed by: Light and Sight; Illumination Terminology; Electric Filament Lamps; Electric Discharge Lamps and Fluorescent Lamps.

The second session, held from 9 to 12 on the morning of May 1, covered: Quantity and Quality; Systems of Light Control; Calculation of Illumination—Point by Point Method; Calculation of Illumination—Lumen Method.

The third session, lasting four hours that afternoon, featured applications—in offices, schools, stores, industry, floodlighting and residential lighting.

There were 78 paid admissions to the course, including engineers, architects, electrical contractors and utility people. The success of this course and a similar program last year has resulted in plans to make this an annual function of the Chapter.

E.C.P.C. Surveys Professional Degree Awards

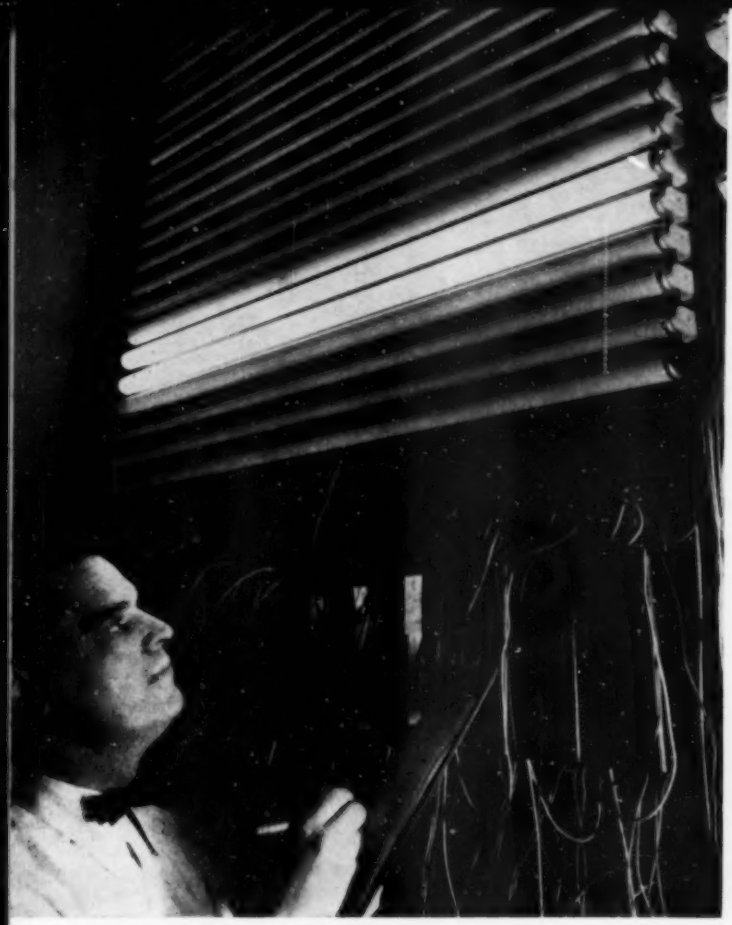
The Recognition Committee of the Engineers Council for Professional Development, under the chairmanship of R. H. Barclay, has completed a survey of the awarding of the professional degree by various engineering institutions. The survey, with its excellent response—of the 146 institutions sent questionnaires 142 responded—will serve as a basis for formulating recommendations concerning the practice of awarding the professional degree as a means of professional recognition.

Of the engineering schools surveyed, 86 award the professional degree while 62 do not. Of the 86 awarding the degree, 74 use professional experience as a basis for awarding the degree; 8 require resident graduate study, and 4 include both experience and graduate study as prerequisites for awarding the professional degree.

In regard to their future plans, 69 colleges will continue awarding the degree, 2 will institute the degree, 13 will abandon it, 49 will continue not to award it, and 17 are uncertain as to future plans. The survey shows that approximately one-fifth of the schools who have offered the professional degree have either dropped it or are making plans to do so.

The Committee also reported an increase of approximately 80 per cent in the awarding of professional degrees in the last five years as compared with the previous five-year period. In the last 10

(Continued on page 14A)



RAPID CYCLING TEST: In Sola's laboratory an accelerated-start life test (½ minute on, 1½ minutes off) was conducted using the rapid-start fluorescent lamps of three different manufacturers. Lamps of each brand were operated from both the Sola Constant Wattage Ballast and another leading make of ballast. The photograph shows two remaining lighted lamps, Sola ballasted, which finally failed after 67,560 starts. The results of the test are summarized in the table below.

RAPID CYCLING TEST, 106v.

RAPID-START LAMP MAKE	LIFE SPAN SUPERIORITY OF SOLA BALLASTED LAMPS
Brand "A" Lamp	46.7%
Brand "B" Lamp	14.7%
Brand "C" Lamp	9.7%
Average All Lamps	19%

Reduces relamping . . . keeps lumen output constant

SOLA *Constant Wattage* BALLASTS

19% more starts on rapid-start lamps with Sola Constant Wattage Ballasts

Ease of starting rapid-start lamps, and length of lamp life from starts, is proportional to the open circuit ballast voltage. Sola Constant Wattage Ballasts have a higher open circuit voltage (300v) from the lamp to the starting aid for positive starting. They are completely safe due to their isolated secondary circuit design . . . listed by Underwriters . . . and CBM Certified.

Their low peak/rms ratio (approx. 1.5 @ 118v) along with excellent wave shape contributes to long lamp life.

Repeated tests in the laboratory, and performance on actual installations show that rapid-start fluorescent lamps operating from Sola Constant Wattage Ballasts form an almost perfect lighting system: long lamp life with frequent starts or continuous operation, and lumen output constant within ±2% regardless of line voltage variations from 106-130v.

WRITE FOR BULLETIN 3F-FL-191

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 35: 103 E. 125th St., Trafalgar 6-6464
PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 272 Centre St., Newton 58, Mass., Bigelow 4-3384
CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • Reps. in Other Principal Cities

(Continued from page 12A)

years, 1387 to 1398 such degrees have been awarded, and of these 917 to 922 have been during the last five years.

The Committee believes this survey to be the most comprehensive of its type ever undertaken and will use it in formulating recommendations on the practice which they believe should be followed in respect to the awarding of the professional degree as a means of professional recognition.

California Groups Pick Winners In Student Design Competition

The Southern California Section of I.E.S. and the local Chapter of the American Institute of Architects announced the winners of their joint competition for architectural students, at the I.E.S. Section's May 5 meeting. The evening meeting opened, with Edward Balogh as Chairman, with a discussion by Arthur B. Gallion, dean of the U.S.C. School of Architecture, on the value of the competition to the student. Frank Gruys then presented the A.I.A. viewpoint of the contest and Michael J. Garris gave the I.E.S. side of the story.

The student winners and the prizes were:

First — $100 — Robert E. Jones
Second — $50 — David G. Clark
Third — $25 — Morris M. Desatoff
Honorable Mention—$10 each—Jim S. Burns, Fred Hoar, and Richard G. Hudgins

In addition to the cash prizes, each of the winners received a certificate of award and a one-year student membership in the I.E.S.

Judges were: Michael J. Garris, Roy Bevan and Jack Rohring for I.E.S.; and Frank Gruys, Paul O. Davis and George B. Allison for the architects' group.

The evening concluded with a discussion and demonstration by Ariel Davis, inventor and scientist, of some recent lighting developments.

Industrial Sight Conservation Discussed at Michigan Conference

A one-day conference on Sight Conservation in Industry was held May 18 at the Kellogg Center for Continuing Education, Michigan State College, East Lansing, Mich. The conference was planned because of the ever-growing recognition of the importance of eye safety and conservation of sight in industry. Representatives of Public Health, the medical and optical professions and community safety organizations joined with industrial leaders in organizing the program, which had the over-all theme of "The Dollar Sign in Vision."

The first speaker was Dr. Joseph Tiffen of the Occupational Research Center, Purdue University, who spoke on "A Dollar's Worth of Vision." Floyd Sell, Supervisor of Industrial Lighting at Detroit Edison Co., discussed "Lighting Your Dollar."

Luncheon speaker was Gerald Phelan, Manager of the Detroit Industrial Safety Council, and the afternoon session featured Carl Garland, Safety Director for the Whirlpool Corp. in St. Joseph, Mich.

A question and answer period and summary concluded the conference.

FORMAL OPENING of Wakefield Lighting Ltd., London, Ont., Canada, April 27. Some 150 people visited the new plant, after which refreshments were served. Dr. Ward Harrison, left, President of the C.I.E., cut the ribbon (red, to signify cutting of red tape in company's Canadian operation). Also shown are Willard Brown, Director of Engineering, G-E Lamp Division; Ruby Redford, Editor of I.E.; M. B. Hastings, V-P of the Canadian Region of I.E.S.; and Mrs. Yates and R. A. Yates, who is V-P and General Manager of Wakefield Lighting Ltd.

Architectural Student Contest Sponsored by Utah Chapter

For the third year, the Utah Chapter of I.E.S. has sponsored a lighting design contest for students at the University of Utah School of Architectural Engineering, with the cooperation of department head Professor Roger Bailey. Chairman of the contest was Amos Jackson, of Jackson and Jackson; and L. B. Gawan, of L. B. Gawan Co., William Brown, of Blomquist and Brown Co., and J. Homer Shaw, of Utah Power and Light, served as judges.

Winners were announced at the Chapter's April 8 luncheon meeting at the Newhouse Hotel in Salt Lake City. They are:

First — $50 — Dale Minson
Second — $25 — Glen A. Lloyd
Third — $10 — Dale Allsop
Honorable Mention — 5 each — G. Gerald Tate, Fernando Juarez, and Don Crawford.

The contest was supported by contributions by Chapter members, representing their companies.

TRIP by chartered bus to Shawinigan Falls, with a tour of the industries there, was the April 19 meeting of the Quebec Chapter, I.E.S.. The 33 members attending were addressed by Mayor Francois Roy at a civic reception at City Hall. The industries visited during the day were the Shawinigan Water and Power Co. generating plants; Dominion Carbide Division of Shawinigan Chemicals Ltd., and Cellophane Division of Canadian Industries Ltd.

the Benjamin Leader Line brings economical, glareless light to classrooms!

Schoolmaster

LOW-COST MAINTENANCE—louver swings down to right or left for easy servicing, or may be removed for maintenance

CHOICE OF MOUNTINGS:

individual units — direct to ceiling
continuous lines — suspended

Quality Light for Close Seeing

Now—scientifically designed lighting quality for classrooms, offices, libraries, etc. The "*Schoolmaster*" provides abundant light output, adequate shielding, ease and flexibility of installation, at low first cost and economical maintenance.

"*Schoolmaster*" utilizes 40-watt Bipin fluorescent lamps or instant-starting 48″, 72″ or 96″ Slimlines. A choice of steel or transparent plastic side panels is available.

Whatever your school lighting problem, either in new construction or remodeling, you'll find the unit with the right solution in the Benjamin-Leader Line Send for latest Data Bulletin on Benjamin-Leader Line Lighting Equipment.

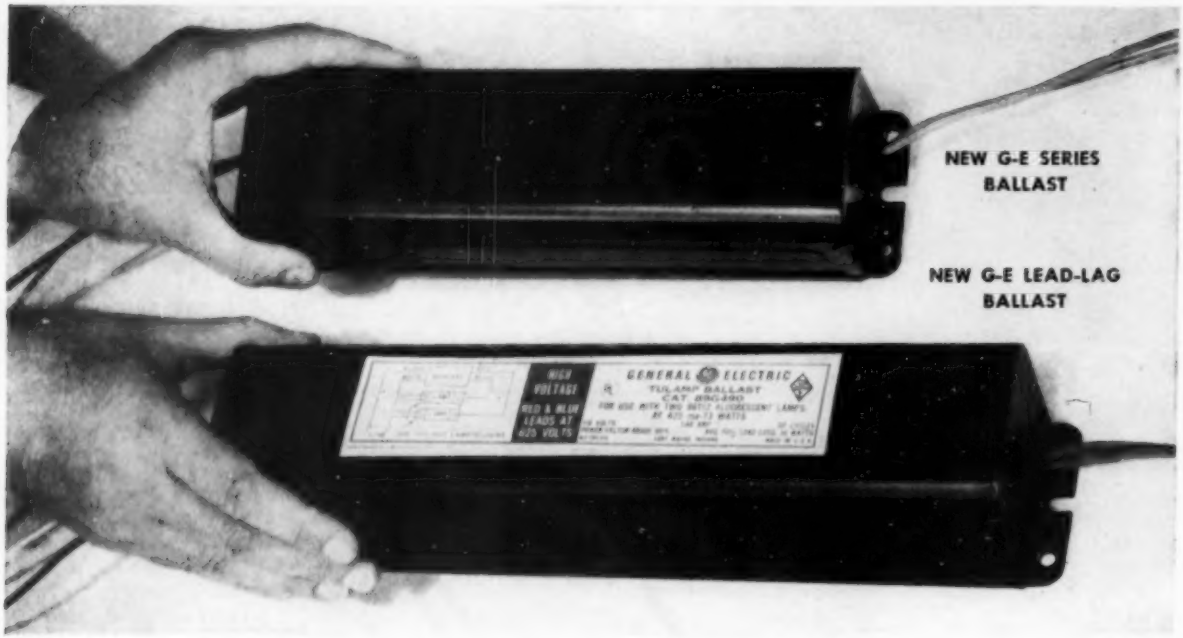
BENJAMIN

Leader Line

Sold Exclusively through Electrical Distributors

Exclusive licensee of the Leader Line in Canada: Robertson Irwin Limited, Hamilton, Ontario

Benjamin Electric Mfg. Co., Leader Division, Dept. I, Des Plaines, Illinois, also makers of famous Benjamin lighting equipment and sound signals for industry, institutions and Commerce.



New G-E Series and Lead-lag Ballasts ...Compare and Choose for Yourself

Here is a comparison of G.E.'s two new ballasts for operation of 96T12 lamps at 425 ma. Catalog No. 89G496 is the newly designed series ballast—smaller, lighter, quieter. Catalog No. 89G490 is the similarly redesigned lead-lag ballast.

BOTH BALLASTS ARE CBM CERTIFIED and contain that full measure of extra quality which G-E engineers into every ballast, but the series ballast, by its inherent design characteristics, gives you more value for your dollar. However, if you prefer lead-lag instead of series, the new lead-lag ballast has been designed to give you the most value compared to other lead-lag ballasts.

THE SERIES BALLAST gives you equivalent performance, in accordance with lamp specifications, and offers a substantial savings in cost and size. At right is a comparison of these two General Electric ballasts. The major areas of difference are printed in bold face. You can see that the series is less expensive, uses less line current, has less wattage loss, weighs less, is smaller, and has a quieter sound rating.

Compare and choose for yourself.

For further information on either series or lead-lag ballasts, write to Section 401-6, General Electric Co., Schenectady 5, New York.

SERIES 89G496		LEAD-LAG 89G490
73	Nominal lamp watts	73
110–125	Circuit voltage	110–125
60	Frequency	60
1.55	**Line Current in Amps**	**1.60**
.425	Lamp Current in Amps	.425
28	**Watts Loss**	**36**
90%	Min line power factor	90%
$10.15	**List Price Each**	**$12.60**
6	No. Units per Package	6
65	**Approximate Ship weight**	**74**
D	**Sound Rating**	**E**
11 ¾	**Over-all length**	**14 ⅛**
11 9/64	**Mounting Length**	**13¾**

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IT SEEMS TO ME

Modular Coordination

I read with interest the article "Let's Have Modular Coordination in Lighting" by T. D. Wakefield, as published in the April issue of ILLUMINATING ENGINEERING.

As Mr. Wakefield pointed out, the American Institute of Architects is a Joint Sponsor of the ASA Project A62 and welcomes such publicity as you have accorded Mr. Wakefield's informative article.

In an era when high building costs call for every possible degree of economy, which does no violence to quality, Modular Coordination points the way to elimination of the cutting and fitting of parts to insure an economical whole. THEODORE IRVING COE, *Technical Secretary, The American Institute of Architects, Washington, D. C.*

It was most gratifying to see the excellent article on "Modular Coordination in Lighting" by Mr. T. D. Wakefield in the April issue of ILLUMINATING ENGINEERING. I am of the opinion that the writer's point was very well taken, that information on this subject is beginning to reach the consumer. Although no especial effort has been made under A.I.A.'s educational program concerning Modular Coordination to reach any audience outside the building industry, there has been an increasing number of indications of consumer interest. Only the other day I sent some information about Modular Measure to a team of writers who needed this material to help them in the preparation of an article for one of the popular national magazines. It is my conviction that the foresighted producer of building material units will begin to prepare himself now for the inevitable consumer insistence on modular unit sizes.

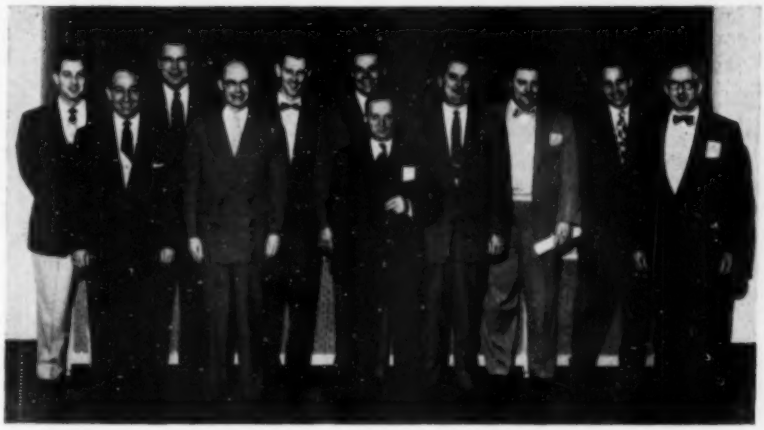
Mr. Wakefield is undoubtedly correct in saying that there may be a number of difficulties for manufacturers of lighting equipment in standardizing on modular sizes, but any such difficulties cannot exceed the obstacles that have been met and dealt with successfully by other industries which have already gone over to modular measure. The machinery already exists for making sure that the sizes which would be developed by lighting equipment manufacturers would be truly modular, in the sense of being dimensionally coordinated with other modular products. The organization of American Standards Association Committee A62 includes a number of "Study Committees," one devoted to each type of building product such as glass block, wood windows, etc. Study Committee #18 is now in process of formation and a new study committee on lighting equipment can easily be initiated.

You are to be congratulated, as also is Mr. Wakefield, in calling the attention of your industry to this significant trend which will influence the standard dimensions of all American building materials units. Let me add that I would be only too happy to assist ILLUMINATING ENGINEERING, The Illuminating Engineering Society or any interested groups within your industry in an exploration of the problems and possibilities which would be entailed in the adoption of Modular Measure. WILLIAM DEMAREST, JR., *Secretary for Modular Coordination, The American Institute of Architects, Washington, D. C.*

We have read with much interest the article by Mr. T. D. Wakefield, "Let's Have Modular Coordination in Lighting." We think it deserves consideration by the industry in the interest of economy in building, and hope that it will receive the attention it merits. May we congratulate you on carrying this article in your magazine. M. EDWIN GREEN, *Registered Architect, Lawrie and Green, Harrisburg, Pa.*

I take this opportunity to congratulate you on the excellent article "Let's Have Modular Coordination in Lighting," which appeared in the April issue of ILLUMINATING ENGINEERING. The author has highlighted both the problems and the importance of producing lighting equipment in conformance with modular coordination standards.

It is only by the increasing production of building materials and equipment on the basis of coordinated dimensions that the building process can achieve the efficiency of an assembly operation as contrasted to the hand-wrought approach dependent on wasteful cutting and fitting. HAROLD D. HAUF, *Director of Professional Relations, The American Institute of Architects, Washington, D. C.*



ELECTRICAL contractors shown here were winners of 16 cash awards for outstanding work in the 1953 Lighting Campaign, made at the March meeting of the Philadelphia Section I.E.S. The campaign, sponsored by the Philadelphia Electric Co. and the Electrical Association, started in September 1953 and ran until January 1954. Winners are: l. to r., Benjamin Busler, Andy Camp, Charles Holm, Edward Barber, William Gillespie, Victor Meierdierck, David Reed, John Cook, Robert Watterson, Harry Hey and Jack Greenberg.

ABOUT PEOPLE

Professor John O. Kraehenbuehl, University of Illinois, has been granted a leave of absence by the university extending from June 1 of this year to September 1955. Professor Kraehenbuehl will spend this sabbatical at 10 Scott St., Broadmoor Park, Colorado Springs, Colo., preparing text material for "Fundamentals and Calculations in Illuminating Engineering," and also outlining and preparing references for a course in "The Surround in Illuminating Engineering," which will be added to the university's Illumination option in 1956. During his absence, his duties will be assumed by **Professor Harry W. Horn,** who will also take over as Faculty Advisor of the I.E.S. Student Branch at the University of Illinois.

(Continued on page 18A)

(Continued from page 17A)

Edward Rambusch, of Rambusch Decorating Co., New York City, is taking an extensive tour of Europe, starting June 24. Mr. Rambusch will visit Portugal, Italy, Denmark, Sweden, France, London and Scotland, taking the greetings of our Society to the counterparts in those countries.

Jack H. Gerard, Director of Gerard & Goodman, Ltd., Adelaide, Australia, visited the I.E.S. Headquarters office May 10, in the course of a trip to this and other countries. Mr. Gerard has served the Illuminating Engineering Society of Australia as President for some considerable time recently.

Supplementing the many honors he has received in the illumination field, **Dr. Matthew Luckiesh** has been presented with the Distinguished Service Award of the Purdue Alumni Association.

The Engineering Institute of Canada inducted its newly elected officers at the annual banquet May 14, at the Chateau Frontenac in Quebec. President is **D. M. Stephens,** Chairman and General Manager of the Hydro-Electric Board and of the Winnipeg Electric Co. Newly elected Vice-Presidents are **B. C. Ballard** of Ottawa, Ont.; **J. O. Martineau** of Quebec, Que.; and **N. B. Eagles** of Moncton, N. B.

Edwin R. Manning has been named Vice-President in Charge of Sales of Litecraft Manufacturing Corp, New York City, in which position he will coordinate the engineering, manufacturing and sales activities in the lighting field. Mr. Manning is an active member of the New York Section, I.E.S.

Fred S. Kinsey, manager of government sales for Westinghouse Lamp Division, has retired after 36 years of service to the company.

George Kielty has been appointed vice-president in charge of the industrial and commercial fluorescent lighting division of Mitchell Manufacturing Co. Mr. Kielty has been with Mitchell for the past four years as Pittsburgh sales representative. To replace him the company has named **John A. Witter** to head lighting equipment sales and **Edward W. Link** to supervise air-conditioning sales in Pittsburgh.

James C. Jangarathis and **K. G. Priestap** have been awarded the Senior Holophane Co. Illuminating Engineering Scholarship for the second semester at the University of Illinois; and **K. E. Fairbanks** has been awarded the Junior Scholarship.

Oscar Cleaver receives citation.

Oscar P. Cleaver, Chief of the Electrical Engineering Dept. of the Corps of Engineers' Research and Development Laboratories at Fort Belvoir, Va., has received an "outstanding" rating for exceptional performance of every phase of his work during 1953. A Fellow of the I.E.S., Mr. Cleaver has guided and directed notable achievements in the field of illumination.

Appointment of **Nelson S. Hibshman,** Brooklyn, N. Y., as Secretary of the American Institute of Electrical Engineers, succeeding **H. H. Henline,** was made effective May 1. Mr. Hibshman was formerly assistant secretary.

The Lamp and Shade Institute of America elected **Morris Thau,** of Mutual-Sunset Lamp Mfg. Co., as president during the first session of the association's semi-annual meeting at the Ambassador Hotel, Los Angeles, April 29-30.

GoldE Manufacturing Co., Chicago, has announced the appointment of **Jack Robinson** as vice-president and general manager. Mr. Robinson was formerly president of Acme-Lite Manufacturing Co.

M. S. Strickler has been named manager of the new General Products Division of Westinghouse Electric International Co., which has been formed to handle lighting equipment and various other products. Mr. Strickler was formerly manager of industrial sales and lighting apparatus.

Don L. Orton has been appointed North Central Regional Manager for Federal Electric Products Co. and its subsidiary Pacific Electric Manufacturing Corp. Mr. Orton will be responsible for sales of the combined line of equipment in Indiana, northern Illinois, North and South Dakota, eastern Iowa, Wisconsin and Minnesota.

The Engineering Societies of New England presented its New England Award for 1954 to **William F. Ryan** at the annual meeting April 27 in the Museum of Science, Moss Auditorium, Boston. Mr. Ryan is engineering manager of Stone & Webster Engineering Corp., Boston.

H. B. Sudekum has been recently appointed Northern Texas District Manager for the Electro Silv-A-King Corp. Mr. Sudekum has been in the lighting field for the past 20 years.

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at Headquarters Office, Technical Dept.*

***Climate and Architecture** by Jeffrey Ellis Aronin, published by Reinhold Publishing Company, New York, 1953; 314 8½ x 11½ inch pages, 291 illustrations; price $12.50.

The author presents with a delightful approach the influences of the sun, temperature, wind, precipitation, lightning and humidity upon architecture as well as their beneficial and disadvantageous effects under given conditions, and systems for the control of these elements. The book is beautifully illustrated with photographs and drawings. The material is drawn from all over the world, with many historical as well as current references. A 15-page bibliography includes the author's comment on each entry; however, these references deal primarily with temperature and weather.

Three of the six chapters are of interest from the lighting (daylighting) standpoint. The introductory chapter, entitled "Background," traces daylighting in architecture and the orientation of buildings from the Eskimo igloo through the early Indian dwellings from Canada to Mexico, the houses of the early white settlers in various parts of the Americas, as well as architecture in Europe beginning with the early Greek, and touches on buildings in the Orient.

The second chapter, "Effect of the Sun on the Earth," in 30 pages summarizes five methods of determining the sun's position: diagrammatic (graphic systems), three dimensional (artificial skys, for example), statistical (tables of data on solar altitudes, azimuths for various latitudes, months and hours), "gadget" (such as the Libbey-Owens-Ford "sun-angle calculator"), and direct observation (in buildings already constructed or using models at the site). Many of the numerous examples cited from the

(Continued on page 20A)

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(Continued from page 18A)

United States, England, Australia and Sweden are explained in detail and illustrated by pictures and tables.

The third chapter, "Design and the Sun" begins with two pages of quotations on the desirability and disadvantages of sunlight in buildings, followed by fourteen pages devoted to solar heating. Fifteen pages of this chapter deal with the architectural design and construction of overhangs and louvers for sunlight shielding, six pages with the shielding properties of numerous specific plants and trees, seven pages with the reflection of light by exterior surfaces, and six pages with housing orientation and layout as it is related to sunlight.

***Artificial Light and Photography** by G. D. Rieck and L. H. Verbeek, published 1952 by Philips Technical Library, Eindhoven, Netherlands; available in U. S. from Elsevier Press, 402 Lovett Blvd., Houston 6, Texas; 340 7 x 10¾ inch pages, 180 numbered illustrations; $8.25.

This volume discusses the use of artificial light for illuminating the subject to be photographed, processing the film, projection and reproduction. It devotes considerable space also to light sources and photosensitive materials. The text is divided into 218 topics, with major sections entitled:

Light and Lighting, includes incandescence, gas discharge and fluorescent radiations, flame sources, units and definitions, photometry, distribution of light, reflection, shadow.

Photography and Artificial Lighting, including negative material, positive material, color material, exposure and exposure time, actinic value, color response, and dark room lighting.

Light Sources for picture taking, dark rooms, reproduction processes, projection.

Applications of Filament and Gas-Discharge Lamps: positioning of lamps and size of subject, lighting for black and white, color, and motion pictures.

Use of Flash Bulbs.

Infrared Photography, Ultraviolet Photography, Microphotography, Clinical Photography, Stroboscopic Photography, Drying Lamps.

In addition to the numbered illustrations there are about 50 full-page black and white plates showing outstanding photographs by European photographers. At the end of the book, beside small reproductions of 43 of these pictures, the authors show the lighting used, camera, film, exposure and aperture. Four color plates are also included with the same detailed data.

Philips' own review of the book calls it "mathematical formulae set out against a background of exquisite photographic reproductions . . . it serves to illustrate the two-fold nature of photography, being an art and at the same time a science, or better, a technique based on scientific principles. . . . The book is suitable both for the professional photographer with a considerable photographic background and for the intelligent and technically interested amateur. . . . As a handbook its value is greatly enhanced by the tables of practical data and by the two extensive indexes (authors and subjects)."

Dutch and German editions of this book are also available from Philips, and a French version is being prepared.

Vorschalgeräte und Schaltungen für Leuchtstofflampen by Carl Heinz Sturm, Second Edition published 1954 by Brown, Boverie & Cie., Mannheim, Germany; 263 4 x 5¾ inch pages, 142 illustrations, 46 tables; price DM 5.25 (approx. $1.25). (Copies may be ordered through Stotz-Kontakt G.m.b.H., Heidelberg-Pfoffengrund, US-Zone, Germany.)

This compact handbook presents much information on European fluorescent lamps It covers in detail lamps and their characteristics, starters, ballasts (even various systems of winding transformers), ballast circuits, overall supply circuits (of various voltages and frequencies, including those used in trains and buses), dimming, trouble-shooting, economics, and ultraviolet lamps and their application. This is a highly technical book giving vector diagrams and equations for most circuits shown. One would hope that some day such a complete volume will be available in English; meanwhile this book should be of interest to everyone concerned with fluorescent lamps who can read a little German.

Cable — Pathway of Power is a new 45-minute motion picture showing how electric wires and cables are made. The film, in color and with sound, details the various steps in the production of wires and cables, starting with copper bars and aluminum ingots and following through to the finished product. Produced by Loucks & Norling Studios Inc., prints of the film are available for showing to interested groups from the Rome Cable Corp. in Rome, New York (main office) or from branch offices in Atlanta, Chicago, Dallas, Los Angeles, Pittsburgh, St. Paul, San Francisco, and Seattle.

Easier Living Within Your Power Electrically, 40-page illustrated booklet available from Arrow-Hart & Hegeman Electric Co., is designed to help the homeowner in building or remodeling, to plan a home complete with electrical conveniences. Featured is a handy check list for the homeowner to determine just what he needs in switches, receptacles, convenience outlets, etc. The list also aids in showing architect, builder or electrical contractor exactly what is required for both present and future needs. The booklet is available from Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford, Conn., at ten cents each. Quantity prices upon request to the company.

NEW MEMBERS

At the meeting of the I.E.S. Council Executive Committee held in Detroit, Mich., May 2, 1954, the following were elected to membership. Names marked * are transfers from Associate Member grade.

ALABAMA CHAPTER

Associate Member:
King, R. L., Alabama Power Co., Selma, Ala.

ARIZONA CHAPTER

Associate Member:
Jones, G. E., Phoenix Electric Supply Co., Phoenix, Ariz.

ARK-LA-TEX CHAPTER

Associate Member:
Speir, H. J., Westinghouse Electric Supply Co., Shreveport, La.

BRITISH COLUMBIA SECTION

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*Cocking, A. H., B. C. Electric Co. Ltd., Vancouver, B. C.
*Racine, R. W., B. C. Electric Co. Ltd., Vancouver, B. C.

Associate Members:
Breslin, J. P., Gough & Co. Ltd., Vancouver, B. C.
Hodgson, C. J., Simpson & McGregor, Vancouver, B. C.
Thomas, M. A., 1553 Robson, Vancouver, B. C.

CAPITAL SECTION

Member:
*Wiseman, R. S., Engineering Research & Development, Ft. Belvoir, Va.

CAROLINAS SECTION

Member:
Smith, F. F., 111 Wedgewood Dr., Greenville, S. C.

CENTRAL NEW YORK SECTION

Associate Members:
Fox, J. C., P. O. Box 200, Syracuse, N. Y.
Jani, R. W., Corning Glass Works, Corning, N. Y.
Quinlan, R. F., Fay-Sullivan, Inc., Syracuse, N. Y.
Siebel, Jerry, 530 E. Washington St., Syracuse, N. Y.
Sullivan, F. J., Fay-Sullivan Inc., Syracuse, N. Y.

CHICAGO SECTION

Member:
Brown, N. E., Commonwealth Edison Co., Chicago, Ill.

Associate Members:
Allen, R. B., Sola Electric Co., Chicago, Ill.
Carlson, A. W., Curtis Lighting, Inc., Chicago, Ill.
Girard, M. J., 343 S. Winfield Ave., W. Kankakee, Ill.
Holmstrom, R. O., Commonwealth Edison Co., Kankakee, Ill.
Laughlin, J. T., Sola Electric Co., Chicago, Ill.
Love, C. L., Sola Electric Co., Chicago, Ill.
Mikita, T. E., Sylvania Electric Products Inc., Melrose Park, Ill.
Rosset, Sidney, Marsh Electric Co., Chicago, Ill.
Simon, L. S., Simon Electrical Sales Co., Chicago, Ill.
Stoesser, A. D., City of Chicago, Bureau of Electricity, Chicago, Ill.
Stromberg, Miss Marion J., Sargent & Lundy, Chicago, Ill.
Tennyson, M. A., Sola Electric Co., Chicago, Ill.

(Continued on page 22A)

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4-FOOT MODELS:
Available in 2 or 4 lamp luminaires, in a complete choice of all lamp types.

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Available in 2 or 4 lamp luminaires, in a complete choice of all lamp types.

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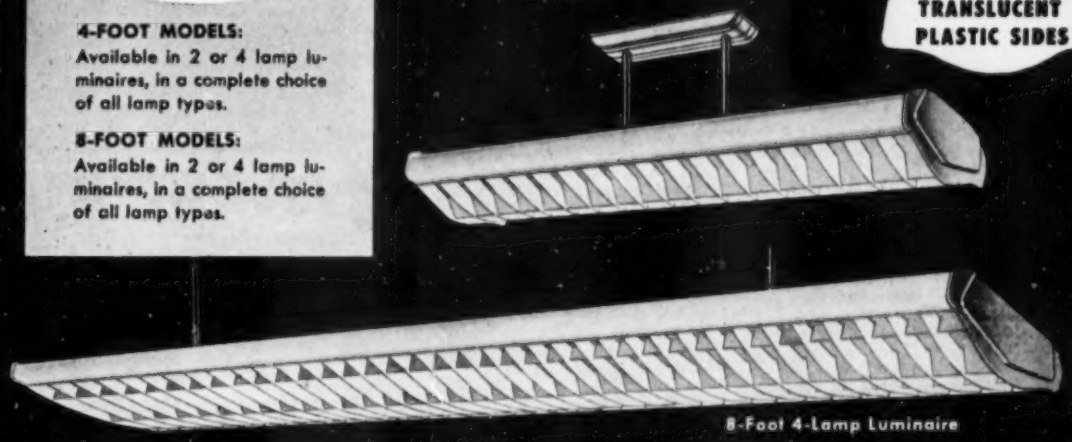

8-Foot 4-Lamp Luminaire

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"General Diffuse" type luminaires; approximately half the light goes up to be reflected from ceiling and upper walls for comfortable, glare-free, uniform lighting.

Semi-translucent side panels provide low brightness contrast, creating modern, streamlined appearance. Plastic sides and louver form one easy-to-handle unit.

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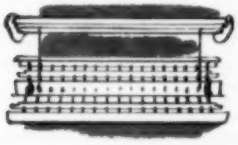
MITCHELL engineering achieves remarkable standards of abundant, glare-free illumination in the "LODESTAR" Luminaires. Important lighting advantages are attained by the substantial upward component which provides a "general diffuse" lighting effect. Semi-translucent side panels provide pleasing low brightness contrast. The superior louver design delivers properly shielded illumination to the working area. Smooth styling, unusually low maintenance factor and surprisingly low cost make the new MITCHELL "LODESTAR" Luminaires outstanding values in commercial fluorescent lighting.



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Owen, R. E., The Miller Co., Meriden, Conn.
Rosenblum, L. I., Beacon Light & Supply Co., Hartford, Conn.
Rossvall, P. W., Rossvall Electric Co., Plainville, Conn.
Spencer, W. B., Stonco Electric Products Co., Boston, Mass.
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Stevens, C. G., Graybar Electric Co., Inc., Reading, Pa.
Walenta, R. C., Graybar Electric Co. Inc., Reading, Pa.

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Gupta, M. P., Philips Electrical Co. (India) Ltd., 7, Justice Chandra Madhab Rd., Calcutta, India.

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Jenks, D. E., Southern College of Optometry, Memphis, Tenn.
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Schmitt, W. C., Northern Light Co., Milwaukee, Wis.

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Fiske, R. F., General Electric Co., Lynn, Mass.

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Young, D. B., Pittsburgh Reflector Co., New Orleans, La.

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Polster, Miss Edythe, 55 E. 10th St., New York, N. Y.
Strauss, H. S., Duro-Test Corp., N. Bergen, N. J.
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Elder, Eldora, Superior Home Supply, San Francisco, Calif.
Johnson, M. R., North Bay Electric Works, Inc., San Rafael, Calif.
McClure, C. E., Weld-Rite Co., Oakland, Calif.
Slavsky, Joe, Superior Home Supply Co., San Francisco, Calif.

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Young, R. L., General Electric Co., Cincinnati, Ohio.

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Cronan, G. L., General Electric Supply Co., Philadelphia, Pa.
Price, B. L., Philadelphia Electric Co., Philadelphia, Pa.
Purdum, S. W., Philadelphia Electric Co., Philadelphia, Pa.
Withrow, W. M., General Electric Supply Co., Philadelphia, Pa.

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Dietrich, B. M., Frame Electric Co., Pittsburgh, Pa.

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Simmons, R. C., General Electric Supply Co., Rochester, N. Y.

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Carter, R. W., Day-Brite Lighting Inc., St. Louis, Mo.
Davis, W. E., Sylvania Electric Products Inc., St. Louis, Mo.
Logan, R. A., Vickers, Inc., St. Louis, Mo.
Lyman, R. T., Garden City Plating & Mfg. Co., St. Louis, Mo.
McNamee, E. J., M. K. Clark & Co., St. Louis, Mo.
Schylling, M. J., Sylvania Electric Products Inc., St. Louis, Mo.

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Harrington, F. A., Marco Industries Co., Anaheim, Calif.
Miller, C. R., Western Precipitation Corp., Los Angeles, Calif.

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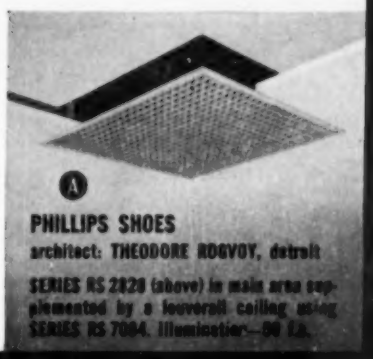
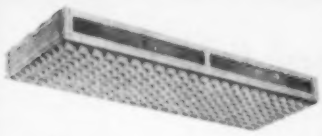


Ⓐ

PHILLIPS SHOES
architect: THEODORE ROGVOY, detroit

SERIES RS 2828 (above) in main area supplemented by a louvered ceiling using SERIES RS 7084. Illumination—50 f.c.



Ⓑ

S. S. KRESGE CO.
SERIES SL 5293 with incandescent spots in main area; SERIES SL 1500 (above) in adjacent area and offices; SERIES SL 7062 in windows. Illumination—100 f.c. in store areas; 40 f.c. in offices.

Ⓕ

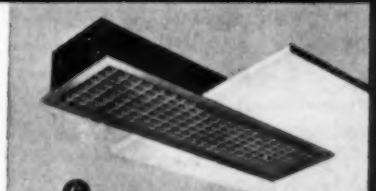
ZUIEBACK'S
architect: MAXWELL WRIGHT, detroit

SERIES 3838-3A (above) plexiglas shielded for general lighting to supplement incandescent accent lites. Illumination—50 f.c.

RUBY-PHILITE LUMINAIRES

...first choice for fine lighting

IN NORTHLAND CENTER



Ⓒ

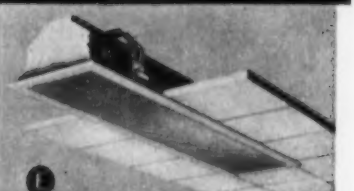
A. S. BECK SHOES
architect: CHARLES SPECTOR, new york

SERIES 7062 (above) supplemented by SERIES 2828 and incandescent downlites. Illumination—50 f.c.

Ⓓ

HUDSON'S NORTHLAND
architect: VICTOR GRUEN, detroit

SERIES TD (above) supplemented by SERIES MOTD for many different service areas thruout the store. Illumination—75 f.c.

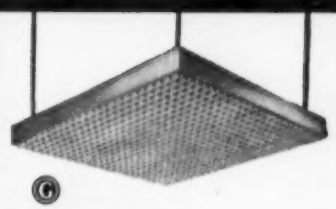


Ⓔ

BETTER MADE POTATO CHIPS
architect: VICTOR BRUEN, detroit
interior: JEROME SCYMASZEK, gen'l mgr.

SERIES SL 25-7 used thruout to obtain 40 footcandles average illumination.

Ruby-Philite luminaires are installed in so many stores in Northland Center that it can serve as a Ruby-Philite showroom. This overwhelming preference was earned by an ability to supply required illumination with minimum luminaires . . . without sacrifice of architectural design or comfort . . . in sites ranging from high-fashion shops to work areas. You, too, will find it easier to gain better solutions to your lighting problems when you consult a Ruby-Philite catalog. **Send for your copy today.**



Ⓖ

BAKER'S SHOES
architect: EMIL FOREMAN, st. louis

SERIES 5858 (above) in main area with varied supplemental general and accent lighting. Illumination—50 f.c.

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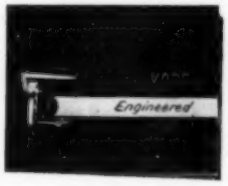

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(Continued on page 29A)

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PLEXIGLAS

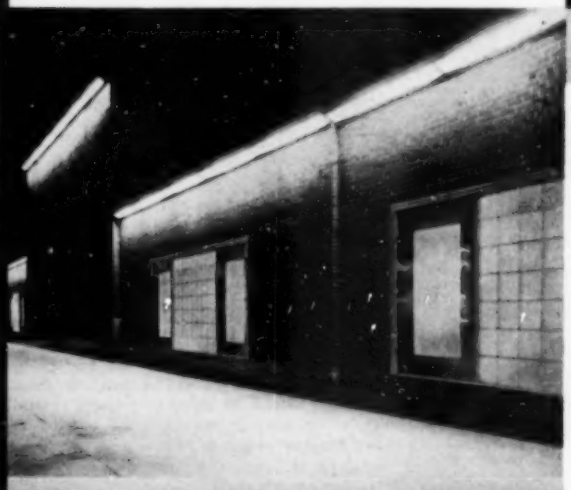
the outdoor plastic— for Trouble-Free Lighting

A plastic that can be used *outdoors* is your best assurance of trouble-free service in interior installations.

PLEXIGLAS acrylic plastic is noted for its dimensional stability, freedom from discoloration and resistance to breakage, regardless of the point of use. That is why it is the preferred material for diffusers, covers, and shields on lighting fixtures.

For outstanding durability, and maximum efficiency in the transmission and diffusion of light, specify PLEXIGLAS. We will be glad to supply details on the usefulness of this multi-purpose lighting material.

Injection-molded PLEXIGLAS covers protect fluorescent lamps in this new type of STREET LIGHTING.



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A REVOLUTIONARY concept of fixture design

One of the most outstanding features of the Ortho-77 is the Uni-Race, a sectional channel that provides a *rigid anchor* and a *fixed power source* for all Ortho-77 models. In continuous runs, it provides automatically *exact fixture spacing, straight alignment,* stability, dimensional accuracy and a continuous open wireway. Uni-Race is an exclusive feature found *only* on the Gibson Ortho-77.

Uni-Race section and couplers are joined in a snug telescopic union.

Uni-Race Assembly is exceptionally rigid though light weight. 20 to 24 feet can be assembled and wired on the floor.

Precision made for dimensional accuracy and straight positive alignment. Plug-in sockets at spaced intervals furnish fixed power source.

Uni-Race provides automatically for exact fixture spacing. Fixtures may be installed without tools after Uni-Race has been mounted.

The Ortho-77 offers for the first time unheard of flexibility plus simplified installation and maintenance. Now without tools and in a matter of minutes you can change fixtures instead of ballasts . . . raise lighting level from two to four light or vary the levels as conditions demand . . . install fixtures at spaced intervals and fill in quickly and easily as needed. Contractors report as much as 50% saving in installation time with the Ortho-77 which means that you can install this revolutionary fixture at no greater cost than a conventional installation.

Uni-Race, mounting and plug-in assembly are exclusive features found only in the Gibson ORTHO-77. Patent Applied For.

Ortho-77 fixtures are wired to plug-in sockets which make contact with receptacles in the Uni-Race channel when closed. Fixtures are completely dead when opened. Being wired in parallel circuits, installation, removal, or interchange can be made without disturbing other fixtures in the circuit.

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Lithonia Lighting Products Co., Inc.
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New Orleans, La. *C. L. Osterberger*

Luminaster, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

Luminous Ceilings Inc.
2500 West North Ave., Chicago 47, Ill.
Louis Rosenstein

Luxor Lighting Products Inc.
Empire State Building
New York, N. Y. *Sergei Marketan*

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

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P.O. Box 950, Newburgh, N. Y. *Norman Macbeth*

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William Kamin

Major Equipment Company Inc.
4603-19 Fullerton Ave.,Chicago, Ill.
Ross O. Major

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 3, N. Y.
Morris L. Markel

Markstone Manufacturing Co.
2460 W. George St., Chicago, Ill. *Martin Schwartz*

Marvin Manufacturing Co.
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Carl O. Anderson

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada *Henri Martineau*

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T. O. McQuiston

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Meriden, Conn. *G. W. Beals*

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Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

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2525 Clybourn Ave., Chicago 14, Ill.
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W. L. Hayes

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P. O. Box 106, Girard, Pa. *Finley J. Gordon*

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40 East Broadway, Butte, Mont. *D. J. McGonigle*

Mountain States Power Co.
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City of Pasadena, California, 302 City Hall
Pasadena 1, Calif. *T. M. Goodrich*

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Morris Thau

The Narragansett Electric Co.
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Earle C. Edwards

Niagara Mohawk Power Corp.
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Reuben Haberman

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Paul E. Poitras

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P. O. Box 1607, Quebec, Que. *Jean Saint-Jaques*

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Nyack, N. Y. *D. S. Schaab*

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Smoot-Holman Co.
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12th & Locust Sts., St. Louis 1, Mo. *W. L. Berry*

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John C. Virden, Ltd.
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Virginia Electric & Power Co.
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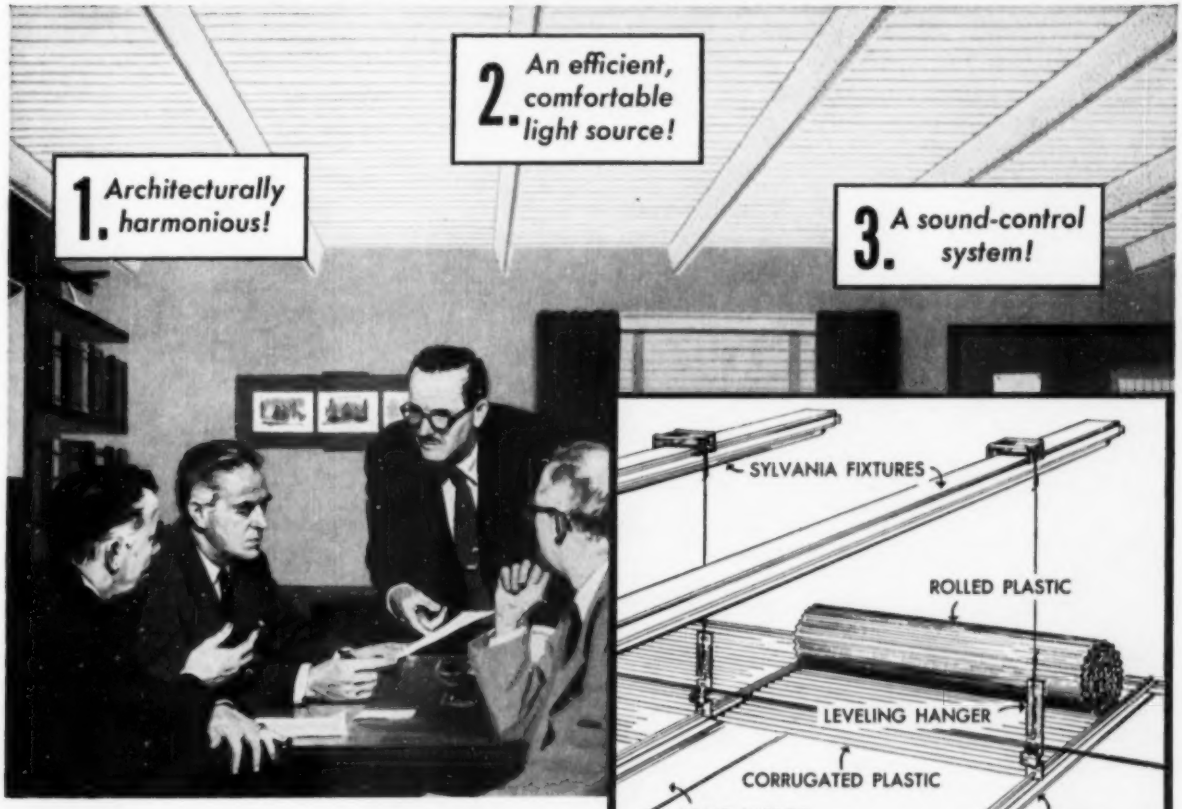
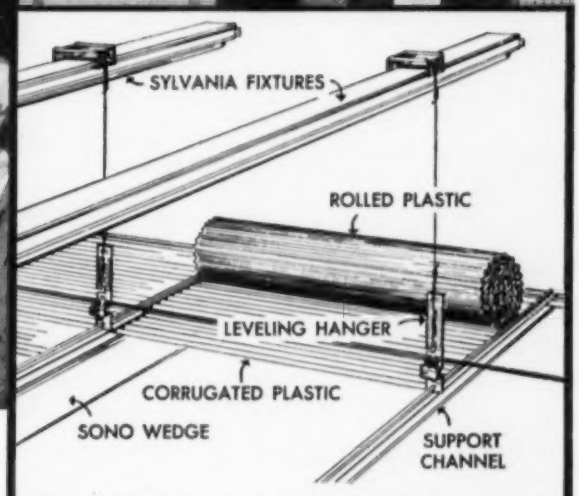
SYLVAN-AIRE

A three-way functional treatment of beauty—sight—sound





Showing details of Sylvania's new functional Sylvan-Aire. For ease and economy of installation, wire supports shown here are attached to lighting fixtures instead of structural ceiling.

Adaptable! Easily Installed! Economical!

You never saw a more fascinating or a more functional system of sight and sound control! It's engineered by Sylvania to serve 3 ways!

1st ...it has the beauty and character of continuous corrugated white plastic.

2nd ...it is a source of soft, eye-pleasing over-all lighting.

3rd ...its inconspicuous V-shaped "Sono-Wedges," lined with thick glass-fiber pads, deaden noise...reduce distracting sound to comfortable levels.

In addition, the corrugated form of the plastic permits air to circulate along the supporting channels. Thus *air-conditioning* also can be effectively introduced.

Flexible in Design!

Sylvan-Aire's light weight and flexibility of design permit it to be readily and economically installed in any conference room, office or working area. Be sure to remind your electrical contractor friends about this latest Sylvania achievement. For full details write today to Dept. 4X-3506 at Sylvania.

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, N.Y. 19, N.Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine Street, Montreal, P. Q.

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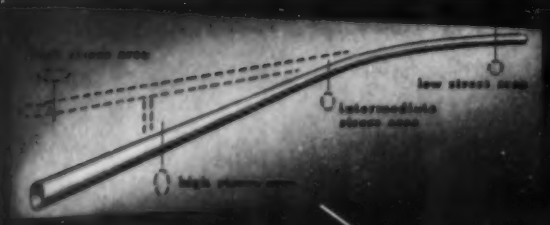
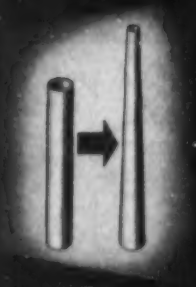


FIRST to provide ample strength in all-aluminum arms and arm-shaft joints through patented, seamless elliptical arms requiring no bracing for lengths up to 8 feet. On longer arms, one horizontally elliptical member, integrally welded to the arm, eliminates need for side-sway bracing.

FIRST to develop fabricating equipment and methods to permit use of high strength aluminum alloys.



FIRST to develop and produce seamless, tapered shafts from high-strength, extruded tubing in a wide range of diameters.

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FIRST to pioneer the Aircomatic method of welding for fast, strong welds and negligible deterioration of alloy strength. All P & K welds are guaranteed . . . all P & K welding personnel and equipment is certified by U. S. Government agencies.

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FIRST to design and build its own tapering machine to handle all diameters of extruded aluminum tubing.

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1. **Electrical, "Remote Control" of POWERSTAT light dimming equipment.**
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POWERSTAT Dimmers, because they are transformers, provide cool operation with maximum efficiency. They give stepless, flicker-free control from full on to full off. Send coupon for full detail.

See Superior Electric's Mobile Display when it is in your area.

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Please send full literature on the LUXTROL System.

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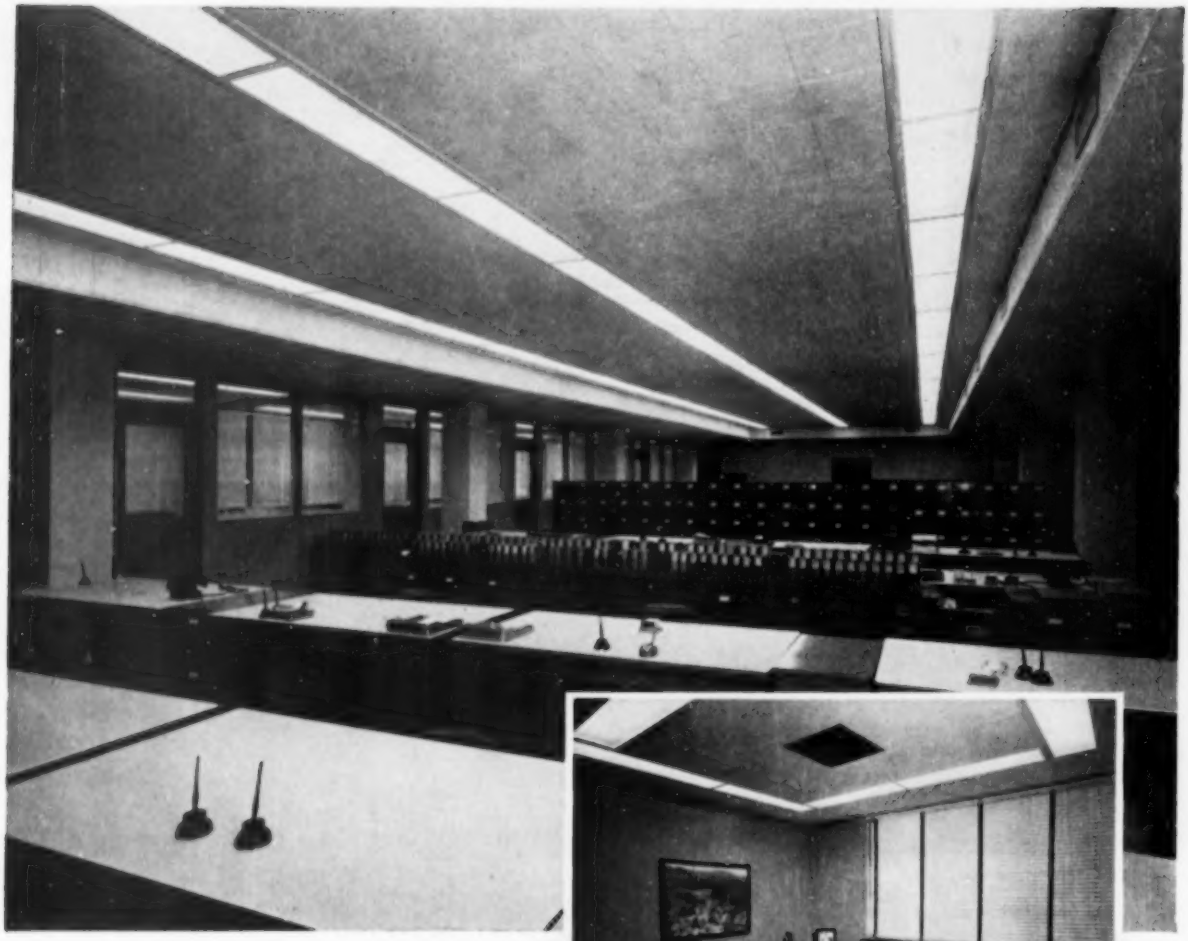
Position.....

Company Name.....

Company Address.....

City.....Zone.....State.....



This

LIGHTING WORKS TO MAKE WORK

LIGHT

JOB: Speed Industries, Inc., New Office Building, Louisville, Kentucky.
ARCHITECT: Nevin & Morgan, Louisville.
ENGINEER: E. R. Ronald & Associates, Louisville.
ELECTRICAL CONTRACTOR: Henderson Electric Company, Louisville.
FIXTURES: No. 5124 and No. 5128, 2-lamp slimline fixtures with hinged doors, modified to accommodate No. 9015 Holophane Low Brightness Lenses.
INTENSITY: Small private office, 70 footcandles, initial average on desk top. Main office, average readings at desk top level, 55 footcandles initially.

Lighting fixtures by LITECONTROL prove the value of up-to-date, glareless office illumination. For, as so many are learning, better light not only means better sight — it means also faster work, fewer errors, and fresher, clearer-thinking, "on-the-ball" workers.

For easy, speedy servicing or relamping of the fixtures in this installation, the hinged frames of each unit are opened by simply loosening the self-retaining catches. If desired, the frames may be removed from the housing by hand.

Day by day, more and more owners, architects and contractors are "turning the switch" to LITECONTROL . . . the lighting that works to make work light. Next time, *you* try it . . . *and see!*

LITECONTROL *Fixtures*

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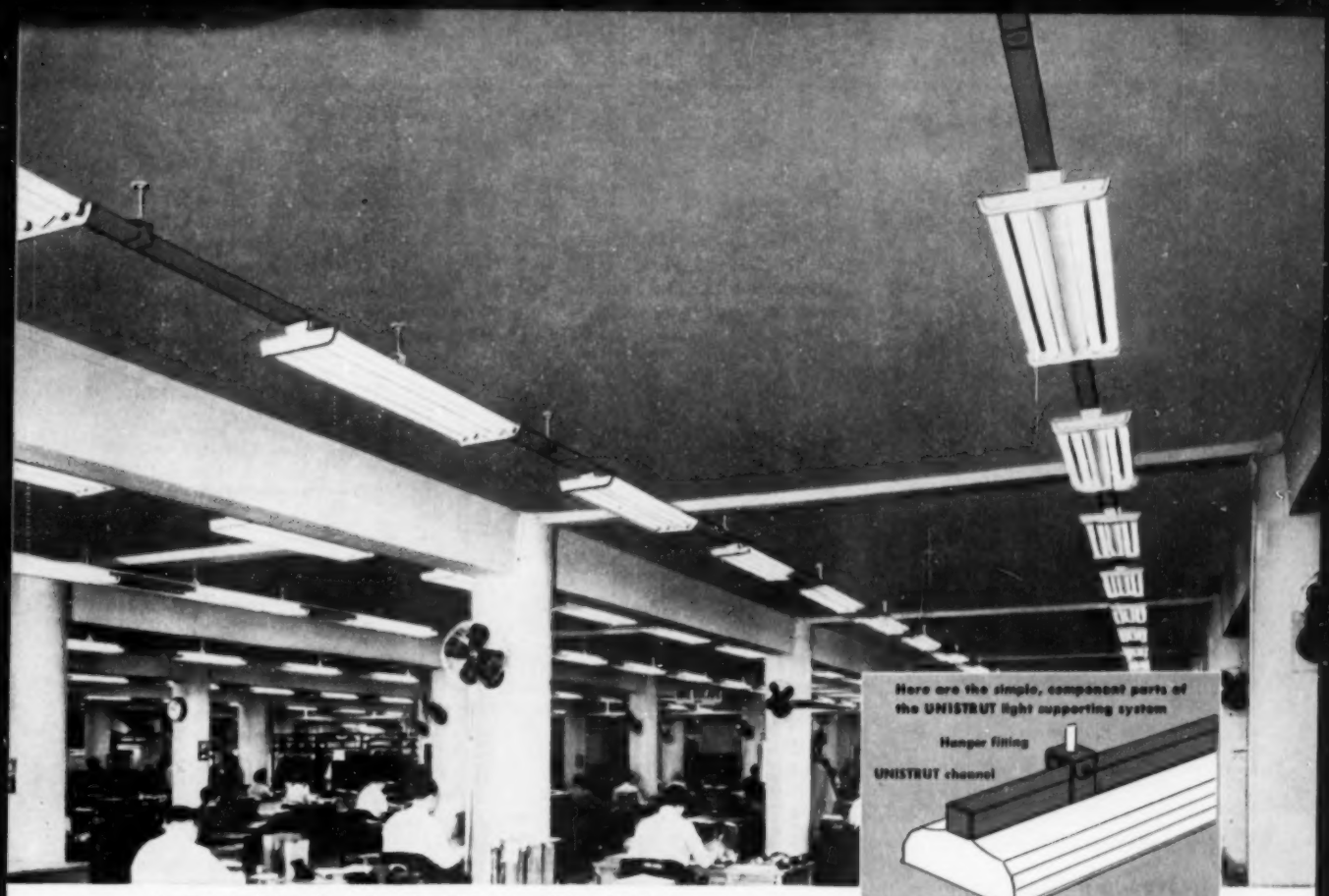
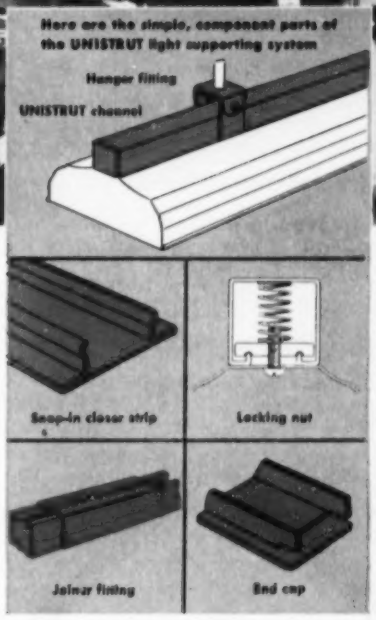
LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS



Installation by: Hultgren Electric Corp., Electrical Contractors, Chicago, Illinois.



50% Savings!

Lighting installed at half the cost with UNISTRUT® *channel and fittings*

New fluorescent fixtures were recently installed on two floors of the Butler Brothers Building, Chicago, Illinois. The savings on this UNISTRUT installation over conventional methods was estimated at fifty percent. How did UNISTRUT reduce installation costs?

By using UNISTRUT channel with its continuous slot to attach fixtures quickly in perfect alignment. And by using the same channel as a wireway. This fast, easy method cut costly installation time in half!

UNISTRUT channel insures true alignment. It provides the utmost in safety because the entire row of fixtures forms a single integrated unit. Fewer hanger rods are needed and a neater, more attractive installation results. Stems or rods may be placed at any point along the channel, permitting installation on irregular ceilings. Fixtures can be fastened in a continuous row or intermittently as shown here.

Get in touch with your UNISTRUT Distributor for the full, cost-cutting facts on light supporting with UNISTRUT framing.

UNISTRUT.

U. S. Patent Numbers 2527587 2529815 2545650 2565382 2580379 2404631 2541908 Other Patents Pending

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in lighting fixtures is continuous dependable performance. For that, look to its source. Behind Miller fixtures—Fluorescent, Incandescent, Mercury for industry, commerce and schools—are 110 years manufacturing know-how—1,000 combined man years field lighting engineering—million-dollar production facilities.

Meriden, Conn. Leaders in lighting since 1844

NEW EQUIPMENT DATA

AVAILABLE WITH COUPON

New manufacturers' catalogs and bulletins listed below are available free to readers of ILLUMINATING ENGINEERING by mailing the coupon. Circle the numbers of those items which you want, drop in envelope or fasten securely to back of 2-cent postcard addressed to Publications Office.

1 New 24-page catalog "PC Glass Blocks for Industrial, Commercial and Public Buildings" is designed to be reference manual. Gives information on physical performance; technical data on light transmission, insulation value, installation detail drawings, complete specifications with easy-to-read pictorial description. Pittsburgh Corning Corp., Pittsburgh, Pa.

2 Bulletin 554E, titled "Litecraft Domelites" in 8 pages, catalogs company's complete line of contemporary incandescent fixtures in a wide variety of styles and mountings, giving complete descriptions, technical lighting data, all well illustrated. Litecraft Mfg. Co., New York, N. Y.

3 Bulletin 34 describes new line of color-flood R-40 lamps designed for decorative illumination indoors and outdoors. Five basic colors may be used singly or combined to secure any shade, and ceramic colors are fused permanently into the glass. Radiant Lamp Corp., Newark, N. J.

4 12-page, 2-color booklet B52 covers prefabricated lighting and tool lines for industrial uses, called String-A-Lite. Assemblies consist of suitable end connectors, molded neoprene outlets, factory molded into 50- or 100-foot lengths of rubber covered cord. Joy Mfg. Co., Pittsburgh, Pa.

5 Catalog shows new line of recessed incandescent fixtures for home and commercial installations, in screwless, detachable design and ready to install with ordinary house wiring. Folder includes specifications and line drawings of various types available. Markel Electric Products, Buffalo, N. Y.

6 Anti-static compounds, under tradename of Merix, and their various applications for destaticizing plastics used in the lighting and other fields, are listed and individual properties described in bulletin. Merix Chemical Co., Chicago, Ill.

7 "Lighting Shopping Centers" is title of company's new 80-page guide for illumination of shopping centers, stores and supermarkets. Completely illustrated with 110 store installation photos, layout plans and diagrams, including interior and exterior lighting data. Holophane Co. Inc., New York, N. Y.

8 Form 4808 is a 4-page pamphlet to assist in selection of emergency lighting equipment; provides schematics, layouts and illustrations of typical installations; shows company's new Exide Lightguard Models M and T. Electric Storage Battery Co., Philadelphia, Pa.

9 Literature describes new Direct-O-Lite industrial fluorescent fixture with hinged reflectors adjustable to direct light where desired from 100% upward to 100% downward and variations between, changes being made without tools. Cornwall Fixture Corp., Cornwall-on-Hudson, N. Y.

10 Booklet "A.B.C.'s of Ultraviolet" explains in non-technical terms various basic uses and advantages of ultraviolet in industrial, commercial and residential applications; gives data on product and personnel protection and use in odor control. Electrical Association, Philadelphia, Pa.

11 Catalog page describes company's PL5 and PL6 outdoor lighting units, the former for marker, warning and signal

(Continued on page 374)

Offer good for two months

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Company _____

Street _____

City _____ Zone _____ State _____

(Continued from page 36A)

applications; the latter with shielding for illumination of steps, walks, patios, driveways and other low-level installations. Gives details of light distribution, construction and specifications. Spero Electric Corp., Cleveland, O.

12 Folder titled "Opal-Glo" introduces and furnishes color chips of new opalescent paint of same name employing the light reflectivity of an aluminum ingredient to achieve various color tones, and said to provide good reflectance even in darker colors. Sherwin-Williams Co., Cleveland, O.

13 New 36-page catalog "Over-all Lighting" is complete with illustrations, engineering data, photometric curves and installation information on wide variety of fixtures made by new Canadian company. Wakefield Lighting Ltd., London, Ontario, Canada.

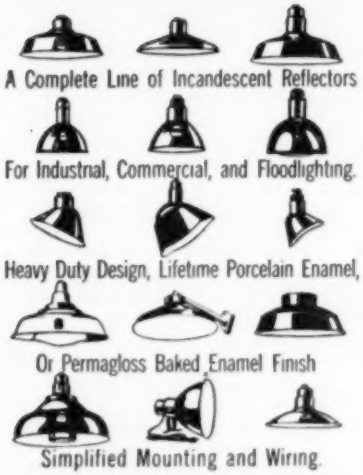
14 1954 catalog of all-aluminum lighting standards for all types of exterior lighting such as highway, area, and street lighting gives data on advantages, various types of pole and arm arrangements available, and shows some special applications. Pfaff & Kendall, Newark, N. J.

15 Catalog R-8 comprises 12 pages on line of recessed incandescent units, is fully illustrated and gives details of dimensions, specifications, framing-in and distribution curves for various types of flush lights. Prescolite Mfg. Co., Berkeley, Calif.

(Continued on page 38A)

Make it a better job

ABOLITE Lighting



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For Industrial, Commercial, and Floodlighting.

Heavy Duty Design, Lifetime Porcelain Enamel,

Or Permagloss Baked Enamel Finish

Simplified Mounting and Wiring.

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THE JONES METAL PRODUCTS CO., WEST LAFAYETTE, O.

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CL SERIES

May also be had with flat end caps. Specify when ordering.

Smart, contemporary design has made this trim, slender fixture popular for many types of commercial interiors. Curved, translucent plastic side panels and beautiful hinged "die-molded" plastic louver bottom panel, with 45° shielding angles, provide an even diffusion of light over a broad surface... at moderate cost.

Offered with a wide range of equipment...

- Available in 48-inch length for two, three or four 40 watt fluorescent tube operation
- Available in 48, 72 and 96-inch lengths for two, three and four Slimline tube operation
- Slimline units may be had in 200 or 430 milliampere
- "D" section plastic side panels will not warp
- Injection "die-molded" plastic louver bottom panel is destaticized, water-proof and color-fast
- May be close ceiling or pendant mounted
- Connecting couplers furnished for continuous row installation
- Easily serviced without dismantling or removing from ceiling
- All parts phosphatized

Investigate the entire line of LEADLIGHT Fluorescent Lighting Fixtures. Write for New Catalog, Today!

LEADLIGHT FIXTURE COMPANY

DIVISION OF OAKLAND ENGINEERING CO., INC.

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☐ Please have Representative call.

☐ Please send me the new LEADLIGHT Catalog.

Name _____

Firm _____

Address _____ City _____ Zone _____ State _____

NEW EQUIPMENT DATA

(Continued from page 37A)

16 Bulletin GEA-6067 is an 8-page pamphlet on sports lighting applications. Pictures planned lighting in football, golf, baseball, basketball and other sports, and describes construction of L-69 floodlight with manual of floodlighting plans. General Electric Co., Schenectady, N. Y.

17 16-page catalog Folio P-54 shows company's new Plexlite line of large area plexiglas fluorescent lighting units, designed for recessed, surface or pendent mounting in a variety of sizes from 4-foot square to 6-foot round. Folder furnishes specifications and installation data as well as photometric information. Gruber Lighting, Brooklyn, N. Y.

18 4-page 2-color folder describes mechanical suspension of Acoustone mineral acoustical tile and Mobilex recessed lighting, a combination said to provide ceiling and lighting flexibility, sound control, modern appearance and economy. Includes technical data on both ceiling and lighting. Day-Brite Lighting, Inc., St. Louis, Mo.

19 New Way Shading Unit by this company is described in folder explaining new type of window shades for large areas of glass block or glass for better daylight control. Said to provide complete shade adjustability for schools, churches, hospitals, plants and other public buildings. L. O. Draper Shade Co., Spiceland, Ind.

20 Factory lighting with A.L.S. industrial fluorescent units is covered in 2-color folder showing wide variety of reflector and shielding arrangements, details of costs of operation and installation, photometric data and other information. Smithcraft Lighting Division, Chelsea, Mass.

21 Folder LS-15 describes Monotube poles for shopping center lighting, shows three different designs and mentions factors bearing upon design selection, as well as a full page of typical installations. Union Metal Mfg. Co., Canton, O.

22 Asymmetric Permaflectors for show windows, perimeter, general and indirect lighting are shown in Bulletin B, describing company's full line of silver-mirrored incandescent reflectors; gives mounting methods, types, distribution curves and other photometric data. Pittsburgh Reflector Co., Pittsburgh, Pa.

23 Bulletin LS-101 dated March 1954 lists company's fluorescent lamps and auxiliary equipments. In addition to usual lamp data, shows types of ballasts available, lampholders and starters for three types of fluorescent lamps and wiring diagrams, as well as list prices. General Electric Co., Cleveland, O.

24 Magic Lites, new line of 24" square units employing regular type C incandescent lamps and Gratelite louver diffusers are described in Bulletin 914. Folder shows details of surface or recess mounting, various patterns possible and photometric data. Edwin F. Guth Co., St. Louis, Mo.

25 16-page booklet B-6098 covers planning commercial and industrial circuit-breaker panelboards; tells advantages of De-ion circuit breakers and characteristics of circuit-breaker panelboards that allow modern circuit protection. Suggests new, shorter and less time-consuming panelboard specification. Westinghouse Electric Corp., Pittsburgh, Pa.

26 Bulletin describes line of recessed lighting units equipped with E-Z Wire Unit incorporating outlet box, socket and reflector, all attached to one end plate for easy handling and splicing into existing wiring. Gives data on shapes and diffusers available. Novelty Lighting Corp., Cleveland, O.

Permanent Efficiency!

SILVERED-MIRRORED PERMAFLECTORS

UP TO DOUBLE the footcandles with standard lamps! That's the performance record of silver-mirrored Permaflectors. This amazing efficiency more than pays for the equipment cost in a short time . . . and continues to pay dividends in lower operating costs. Whatever the wattage, or the job—a Permaflector does it best!

1 Crystal glass, made in our own glass division, is clear, sparkling, uniform, flaw free.

2 A double plating of pure silver assures maximum light reflectivity.

3 A copper envelope over the pure silver provides lifetime protection for the silver.

4 A final silver-gray, satin finish gives added protection, blends with all interiors.

INCANDESCENT LIGHTING EQUIPMENT

- Show Windows
- Show Rooms
- Store Interiors
- Building Fronts
- Offices
- Schools
- Gymnasiums
- Power Houses
- Churches
- Hospitals
- Public Buildings
- Plants & Shops
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and many other uses

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411 OLIVER BUILDING, PITTSBURGH 22, PA.

FLUORESCENT "Pittsburgh" Permaflector INCANDESCENT

Lighting

REPRESENTATIVES IN PRINCIPAL CITIES • WHOLESALERS EVERYWHERE

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STREET LIGHTING SALESMAN

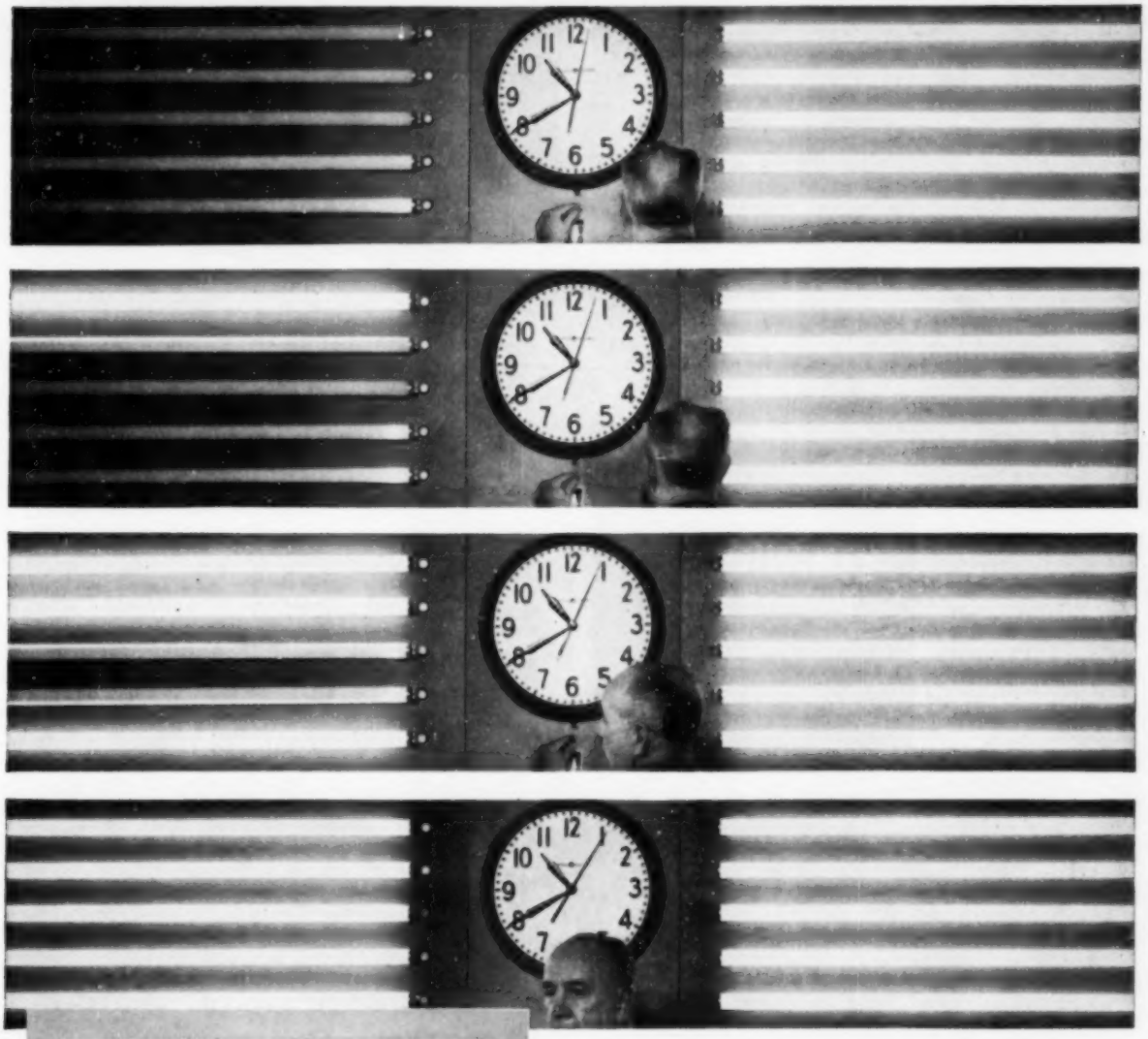
Available now. Has wide acquaintance with utility, municipal engineering, and railroad executives in Midwest, South and East. Sold large volume of plastic street lighting diffusers past several years; travelled 30,000 miles year by car. Full reference as to ability and character. Address Box 213, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

LIGHTING SALES ENGINEERS

This is your opportunity.

Nationally advertised West Coast Manufacturer of a broad line of Commercial and Industrial Fluorescent and Slimline Lighting Fixtures has opening in territories East of Mississippi River. Write with full particulars. Box 214, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

YOU EXPECT THE BEST VALUE FROM G-E FLUORESCENT LAMPS



New G-E "Rapid Start" lamps light up twice as fast as others

This series of pictures shows how General Electric can save you the annoyance of waiting for light.

All the lamps were started as the second hand on the clock reached zero. Within two seconds, the G-E Rapid Start lamps—right of the clock—were fully lighted. It was nearly *six* seconds before all the regular lamps, left, lit up.

G-E Rapid Start lamps eliminate the starter, cause of up to half of regular lighting maintenance troubles. They have long life, too. Reason: a triple-coil cathode that holds more starting chemical.

General Electric Rapid Starts are another example of why you can *expect* the best value from G-E fluorescent lamps. For free folder, "Facts About Rapid Start", write: General Electric, Dept. 166-IE-6, Nela Park, Cleveland, O.

GENERAL ELECTRIC

COMPLETE LINE OF
QUALITY FLUORESCENT
AND
SLIMLINE FIXTURES
FOR EVERY REQUIREMENT...
COMMERCIAL & INDUSTRIAL
BY
WILEY
Pioneers in Fluorescence
Since Its Inception

- Modern, functional designs to harmonize with any architectural motif.
- Stock fixtures adaptable for all lighting layouts.
- Units designed for quick, easy erection. A minimum of "on-the-job" assembly.
- Patented E-Z Servicer.
- District Sales Engineers available for prompt cooperation.

Designed and completely manufactured by WILEY, with ETL Certified Electrical Components

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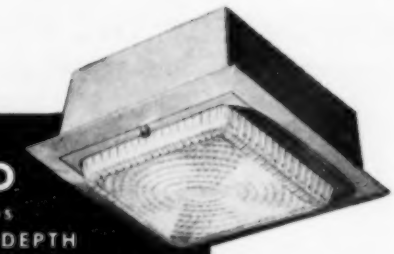

KESCO
Non-ferrous
SHALLOW DEPTH
CANOPY FIXTURE

KESCO recessed canopy fixtures are ideal for installation in poured concrete exterior canopies, where rugged construction, shallow depth, and durable finish and materials are requirements.

- 4½" Depth
- 10¼" Square
- 7/32" Wall Thickness
- Cast Aluminum Box
- Separately Detachable Two-Piece Satin Finish Cast Aluminum or Bronze Frame
- Drop Hinge Assembly for Easy Bulb Replacement and Cleaning
- Approved for One 150-Watt Incandescent Lamp
- Flat or Drop-lens Type

Underwriters Approved —
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Manufacturers Representatives:
A limited number of territories are still open. We invite your inquiry.

KESCO
K-E SALES CORPORATION
P.O. Box 2228 Gardner Station
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NEW LIGHT PATTERNS FOR SMART INTERIORS

"Howard's" of San Francisco, recently remodeled, clearly shows how efficiently and smartly stores may be lighted with Sunbeam's new, "large area" recessed #3600 fixtures. Especially adaptable to various geometric patterns, these 2x4-foot units are available with various light diffusers. Groups of nine units with crystal-clear, low brightness lens panels, pattern #70, in a skylight effect, provide 200 foot-candles of sales-producing illumination in the sportswear department. This high intensity is achieved with remarkable low brightness and minimum glare from normal viewing angles. Rectangular patterns of 32° louver-shielded units installed in other areas giving 75 ft-c.

SUNBEAM LIGHTING COMPANY
777 E. 14th Place, Los Angeles 21, California

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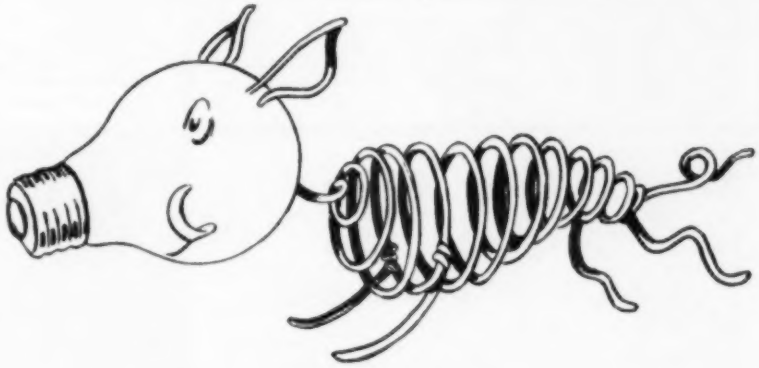
GET AWAY WITH Your MONEY



The Cur-rentelope elopes with excess current if you don't watch out. The Cur has his lair in plants and offices that haven't followed the suggestions in the *Champion Maintenance Manual** — and that aren't equipped with the right lamps — efficient, long-lasting Champion Incandescent Bulbs and Fluorescent Tubes.

**May we mail you a free copy?*

CHAMPION LAMP WORKS
588 Broad Street, Lynn, Massachusetts

CHAMPION

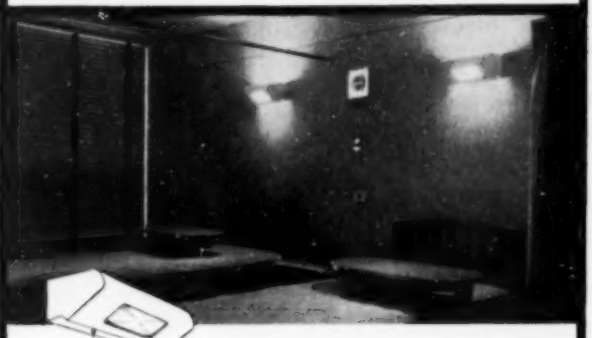
DAY-BRITE PLEXOLINE® lights a nurse's training classroom. The problem solved here was the creation of high level general illumination without glare. PLEXOLINE does an equally good job in administrative offices and waiting rooms.

DAY-BRITE RECESSED "TROFFERS" supply general lighting in this operating room at all times and, during operations, eliminate dangerous brightness contrast between intense local lighting at the operating table and the surrounding area.

How to solve specific hospital lighting problems with

DAY-BRITE

These are actual Day-Brite hospital installations . . . each a "best buy" answer to one of the many lighting problems in this highly specialized field.



DAY-BRITE BED LAMPS are made specifically for patient room lighting. There's comfort and convenience here for the patient—direct light for reading, indirect light for general use. Sparkling stainless steel finish is easy to keep clean.

DAY-BRITE CFI DAY-LINE® industrial fixtures handle a man-sized lighting chore in a central kitchen. Here, as in other service areas, these rugged CFI's resist vibration, fumes and moisture, give you top performance under toughest conditions.

DAY-BRITE EXIT SIGNS mark emergency exits, direct corridor traffic in a large hospital. Doubly dependable, these trim, handsome Exit Signs are equipped with two sockets for continuous operation in the event one lamp fails. UL approved.

452

THE DAY-BRITE LINE gives you two great advantages when you engineer hospital lighting.

It's a *complete* line—giving you a wider selection of fixtures to meet the many and varied lighting problems in a hospital.

It's a *quality* line at *competitive prices*—giving you an extra edge in performance without throwing costs out of line.

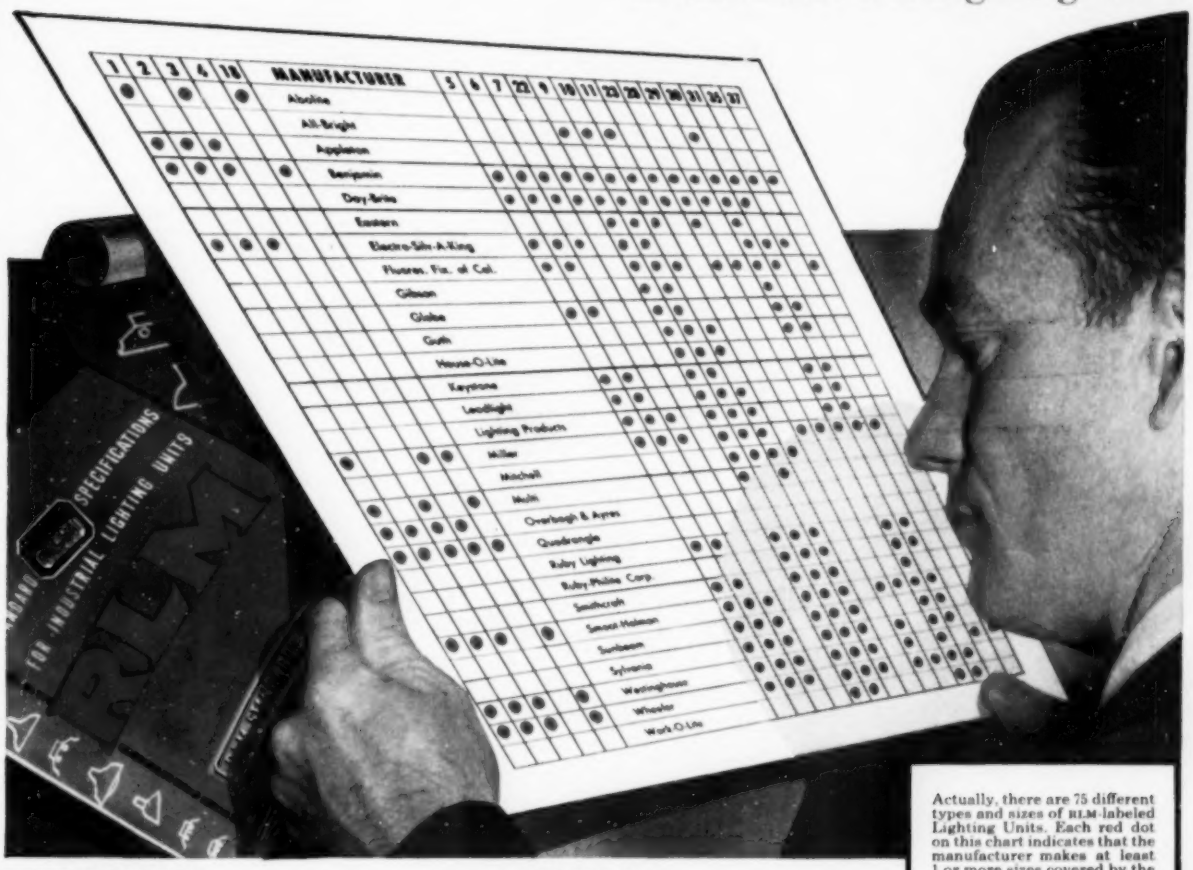
Those two basic advantages of a Day-Brite specification are just as potent for your school, industrial, office and store lighting installations. Your Day-Brite representative has the facts and demonstrations to back up these promises.

"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

CALL OR WRITE YOUR NEAREST DAY-BRITE REPRESENTATIVE

Here are your answers to 2 IMPORTANT QUESTIONS about Industrial Lighting Units



Actually, there are 75 different types and sizes of RLM-labeled Lighting Units. Each red dot on this chart indicates that the manufacturer makes at least 1 or more sizes covered by the particular RLM Specification.

Key to Spec. Nos.:

INCANDESCENT UNITS:

1. Dome (100-1000w)
2. Deep Bowl (100-1000w)
3. Sym. Angle (100-1000w)
4. High Bay (500, 1000w) Porcelain Enameled
18. Glassteel Diffuser (200-1000w)
40. High Bay Aluminum (500, 1000w)

FLUORESCENT UNITS:

Closed-End Reflectors:

5. 2-40w lamps, 48"
6. 3-40w lamps, 48"
7. 2-85w lamps, 60"
22. 2-40w w/shield, 48"

Open-End Reflectors:

9. 2-40w lamps, 48"
10. 3-40w lamps, 48"
11. 2-85w lamps, 60"
23. 2-40w w/shield, 48"
28. 2-58w, 72"
29. 3-58w, 72"
30. 2-75w, 96"
31. 3-75w, 96"

Semi-Direct Units:

35. 2-40w, 48"
36. 2-58w, 72"
37. 2-75w, 96"

Chart as of Jan. 1, 1954

1 WHY are RLM Specifications Important to me?

ANSWER: RLM Specifications furnish you with basic, nationally-accepted minimum standards of efficiency, design, performance and quality in industrial lighting equipment. This latest-edition 52-page RLM Specifications Book puts all 21 RLM Specifications at your fingertips, complete with coefficient of utilization tables and candlepower distribution curves. In addition, there are four pages of reasons why RLM Specifications are important to everyone who buys, sells or specifies industrial lighting equipment. Send for your COMPLIMENTARY COPY of the RLM Specifications Book ... there is no obligation!

2 WHO makes RLM-Labeled Units I want to Specify?

ANSWER: As shown by this chart, which is also included with the RLM Specifications Book, there are 29 different manufacturers who make RLM-labeled lighting equipment. Each RLM Unit must conform to the minimum performance and quality standards required by RLM Specifications. However, every manufacturer is free to incorporate his own special features, construction refinements and operating advancements — such as sockets, control equipment, wiring, etc. Send for your FREE RLM Book for more details. RLM Standards Institute, Suite 823, 326 West Madison Street, Chicago 6, Illinois.

RLM STANDARDS INSTITUTE INCORPORATED

The Source for RLM Standards and Lighting Equipment Manufacturers

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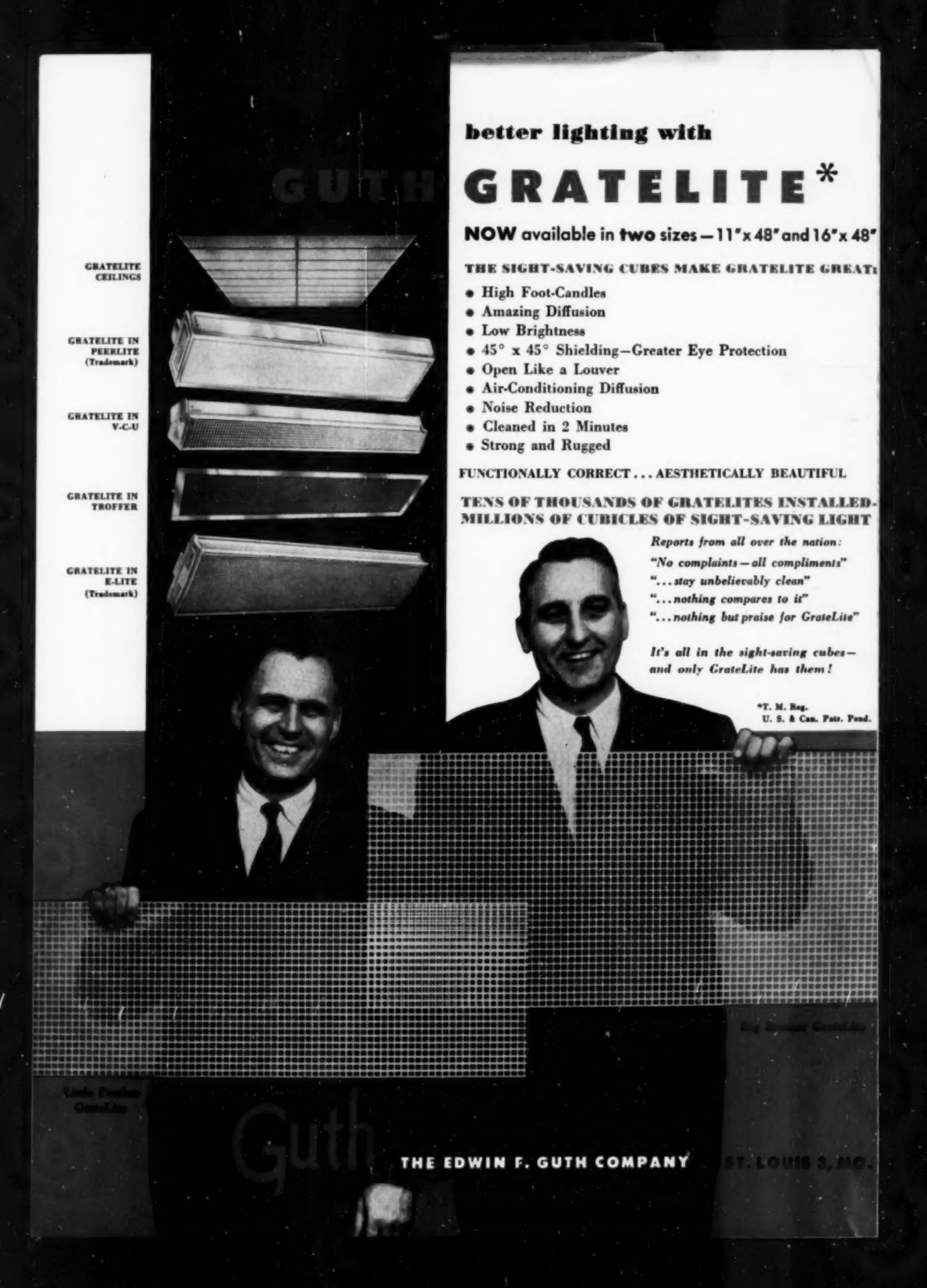
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NOW available in two sizes — 11" x 48" and 16" x 48"
THE SIGHT-SAVING CUBES MAKE GRATELITE GREAT:
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• 45° x 45° Shielding—Greater Eye Protection
• Open Like a Louver
• Air-Conditioning Diffusion
• Noise Reduction
• Cleaned in 2 Minutes
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FUNCTIONALLY CORRECT . . . AESTHETICALLY BEAUTIFUL
TENS OF THOUSANDS OF GRATELITES INSTALLED-
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Reports from all over the nation:
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